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nuance

NORTHROP UNIVERSITY MAGAZINE



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What do presidents, vice-presidents, and corporate management at ITT, BATTELLE, ROHR, HARRIS, MOTOROLA, CONTROL DATA CORP., IBM, RANSBURG, and TRW have in common?

Degrees from Northrop University

And thats not all....



On the cover:

©Paper Airplane 1984
Photo by Chauncey D. Bayes

The single-image that celebrates 200 years of breaking through the barriers to air and space flight.

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IVERSITY MAGAZINE

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Alumni of Northrop University
share very interesting company as
professors and research directors at
U.S.C., Cal Tech,
U.C.L.A. School of Medicine,
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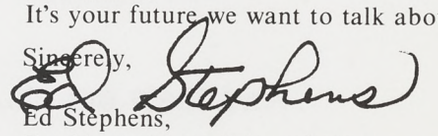
In fact, the invisible university of alumni
includes: the Financial Manager,
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Sincerely,



Ed Stephens,
President, Alumni Association

Alumni President
Northrop University
Ed Stephens '48/'61
Mechanical Design Engineer
Infodetics, Inc.

nuance
NORTHROP UNIVERSITY MAGAZINE

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WHO'D LET A 23-YEAR-OLD WORK WITH THE WORLD'S MOST SOPHISTICATED LASER SYSTEM?

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RESPONSE

A Plaudit, or two

Congratulations on your April, 1983 issue of NUANCE! The cover, as usual, was provocative; the advertisements were unobtrusive and done in good taste; and the articles, especially the ones on "Organic Pascal" and "The Shangri-La," really captured my interest.

The staff of NUANCE really deserve a commendation for publishing a great magazine, issue after issue. The quality of articles, the format, and the philosophical outlook ranks as a superior publication alongside its counter parts. I doubt if other school publications, even at larger universities, can match the intensity of NUANCE.

Again, a well-deserved plaudit for your magazine.

Steven Holzapple
English Department
Northrop University

First, let me congratulate you on NUANCE! It is excellent! Excellent design, interesting articles, well edited and put together. I hope it will be a success, and I would like to be on your future mailing list and would be glad to pay a subscription, or make a contribution for each copy. I am enclosing a contribution, not necessarily for this issue, but just to help NUANCE.

I thought your presentation of my article was superb. ("Sharing the Skies", April, 1983) The artwork was particularly good and I thank you.

My book, however, is not about Eastern Airlines, although there will be a little of Eastern in it. It is my own memoirs of the airline industry as I saw it develop, both domestically and internationally.

F.D. Hall
President Eastern Airlines, Retired
South Woodstock, Vermont

I received NUANCE, April, 1983 today. It is, without hesitation, the best single issue of a magazine I have ever seen.

Editorial content is superb, design and graphics are excellent and print, at the least matches all the above. In fact, anything I might say would be an understatement.

Congratulations to you and your staff on an excellent publication.

Bernard J. Hatt, Vice President
Subia, Inc.
Inglewood, California

Reprints, please

This is a request for permission to reprint portions of your excellent article "The Learfan Challenge" from NUANCE, October, 1982. Excerpts will be used for the Professional Women Controllers (PWC) Newsletter, *Newswatch North* dedicated to Moya Lear.

Mrs. Lear has been offered an honorary membership in (PWC). PWC promotes aviation safety, communication, and cooperation between Air Traffic Controllers, Users, and Industry.

Information on the Learfan and LearAvia has been very difficult to locate. I was about to give up when NUANCE was passed on to me by a friend from Kodiak, Alaska. The NUANCE treatment was very fair and enlightening.

Susan House
PWC Newswatch North

I would like to share the article, "The Challenge of Ethics," (NUANCE, April, 1983) with the other students in my Ethics Class. Ideally, just making a few photocopies would work easily for me, and that is why I checked with your office.

The class is part of the College of Professional Studies Program at the University of San Francisco.

Again, thank you.

Robin Strauss & Company
San Francisco, California

I may have mentioned it on the telephone, but if you would mail a copy of NUANCE, October, 1982 directly to Mrs. James H. Doolittle, it would be greatly appreciated. Jim kept the original copy at his Monterey office and Mrs. Doolitlle scolded him in my presence when they visited us here in Los Angeles last week.

Fred E. Jacob
Glendale, California

NUANCE looks great! Can I mention it in a top-margin item of CURRENTS? If so, I'd like to let members write to you for sample copies. You might receive 100 requests. Let me know if this is OK.

Ann Lowrey Bailey
Exeuctive Editor
CASE CURRENTS
Washington, D.C.


ATARI 800

Reflections in the Mind's Eye

COMPUTER EXPLORATIONS IN VISUAL THINKING

James Tanaka

Computer graphics technology may provide a link between the worlds of art and engineering. The dynamics of the new visual medium encourages the exploration of new forms, new perspectives, new environments. Geometric representations no longer have to be lines and planes, they can be defined in three dimensions, rotated, explored and recreated within seconds. For artists, architects and designers computer graphic technology means the freedom to explore, to take visual risks which were not possible or practical on the drawing board.

Ordinary two-dimensional representations of objects in photographs and drawings, have a static, unalterable quality. The observer is bound to the given viewpoint of the scene portrayed, a frozen image in time. In contrast, computer graphic images are not drawn by an artist's hand or captured by a camera lens as much as they are sculpted or modeled in space. The objects can be rotated or moved in perspective by systematically manipulating its x,y,z, coordinates. Because of their mathematical properties, computer images can be rescaled to become larger or smaller, parts can be extracted and exploded, or cloned from a pictorial database. In a three dimensional graphics system, the image can be explored visually as if it were being held, or walked around or through. In some respects the computer graphic image is a more informative representation than even the real object. For instance, the view from inside an object becomes a totally new vantage point for exploration.

Because the entire form is mathematically modeled in the computer's memory, it becomes more "object-like" and less "picture-like". The viewer at the keyboard can interactively juggle the position of the image-objects around the screen. No longer restricted to the given perspective of the camera's eye, the viewer choreographs both the position of the objects in the picture and the desired viewing location of the action. In this type of interaction, there is a feeling of first-person engagement with the visual forms not experienced in conventional still or moving picture.

Just as computer generated image-objects take on a life of their own, the environment in which they are placed also becomes a separate imaginary world. In a sense, the computer display serves as a looking glass into this imaginary world where improbable or impossible worlds can be conjured up and simulated as easily as real ones. The foundation of this make-believe world is the language of math-

ematics. The computer graphic environment can simulate any phenomenon that can be described by its mathematical properties. For example, object surfaces can be illuminated from multiple light sources resulting in irregular shadow effects or wave forms can be programmed to simulate the undulating motion of an ocean swell.

The interaction between image-objects and image-environments is the delight and wonder of computer graphics. When mathematically modeled objects with a certain set of attributes are placed in mathematically modeled environments with a very different set of characteristics, intriguing and sometimes unexpected interactions occur. In the computer graphic world, different scenarios can be staged and evaluated without real world consequence. This gives a designer the advantage of previewing potential designs before committing to a final plan.

Thinking in 3D Space

Although technological advances have made visual images more accessible there is much to be learned about how these images can be used effectively to mediate intellectual thought. There is a gathering body of research in the field of cognitive psychology that strongly suggests that we think differently with pictures than we do with words or abstract symbols.

Perhaps the most famous visual thinker of all time was Albert Einstein. His classic "thought experiments" were impressive exercises in visual thinking. By imagining himself riding along a beam of light, Einstein gained revealing insights into the nature of relativity. By his own admission, the most difficult aspect of the work was translating his visual images into the language of mathematical symbols. Is it possible to train the process of visual thinking? Schools of art and design emphasize the intellectual process of visual and spatial problem solving from an aesthetic perspective. Traditional curricula in engineering drafting have at least been partially successful in teaching the basic concepts of three dimensional representation. But what role, if any, can computer graphics play in the instruction of visual reasoning?

"The biggest challenge in computer graphics is not so much a technological one as a human one."

In a joint venture with the National Science Foundation and the Atari Research Institute, the Visualization Project at Northrop University is investigating the potential use of a computer graphic imagery for developing visual thinking skills. Previous research studies have demonstrated relationship between spatial thinking and mathematical performance. In the Visualization Lab, we are studying whether it is feasible to train spatial thinking through computer graphics. Because of the computer's ability to model three dimensional objects quickly and efficiently, the computer graphics medium is an ideal avenue for teaching concepts of spatial problem solving. Preliminary results of the investigation have demonstrated that there are many areas of visual thinking that are better explained using computer graphic technology than conventional means.

Computer Graphics and the Design Processing

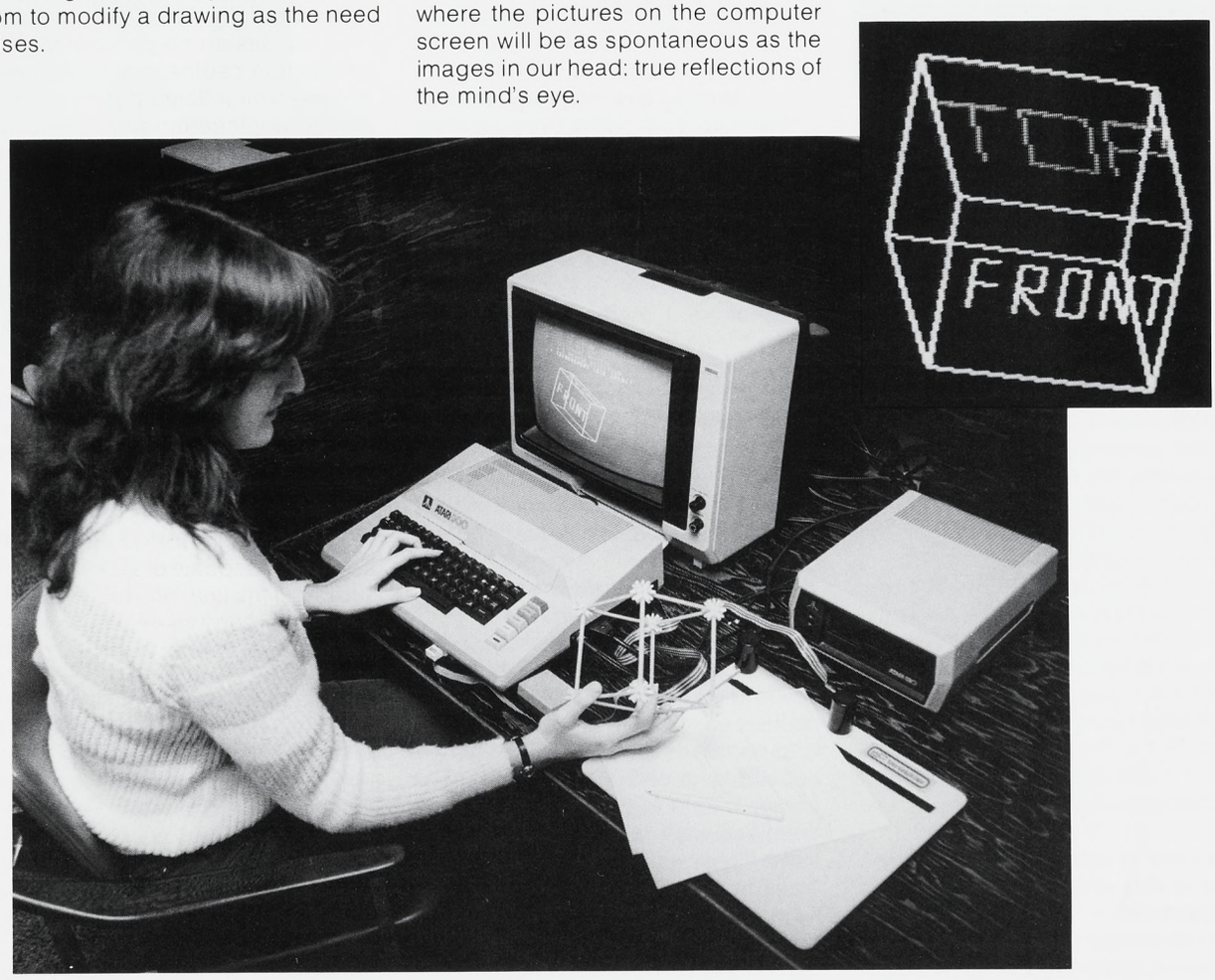
Typically, an engineering design goes through four major stages of development: feasibility, preliminary design, detailed design and evaluation. In the feasibility stage, a number of different concepts are proposed and considered in terms of their viability. From the group of possible candi dates, a single concept is selected and more fully developed in the preliminary design stage. Before actual production begins, a detailed design is done which describes the concept from an engineering standpoint. In the evaluation stage, the designer evaluates the concept in terms of its production requirements and makes any necessary modifications in the design.

Engineering designs are conceptualized, developed and produced through successive refinements of scaled drawings rendered by hand. In the execution of a design, the major advantage of scaled drawing is that it creates a mechanism for dividing the production work into a series of tasks. After the detailed design is completed, the drawing plans are parcelled out to the specialty groups who concentrate on various aspects of building and assembling the final product. Communication between these specialist groups is mediated graphically by the designer through continuous revisions of the scaled drawing which reflect the current state of the design.

In this traditional process, there is a clear distinction between those who think about the design of a product and those who actually make the product. The dichotomy between the product thinkers and product makers becomes less defined when the design medium is computer graphic based. In a sense, the electronically generated drawing puts the design pencil in the hands of the builders, as well as the designer, allowing them the freedom to modify a drawing as the need arises.

For the Visualization Project, the next phase of research is directed toward actively training spatial problem solving through the use of computer graphics. As part of this research, we are designing a curriculum in spatial thinking applicable to anyone who solves problems in a visual domain, whether that be the design engineer or the graphic artist. The excitement of the visual innovations is the realization that we are fast approaching the time where the pictures on the computer screen will be as spontaneous as the images in our head: true reflections of the mind's eye.

James Tanaka *coordinates the NSF-ATARI research project at Northrop University and teaches Computer Graphics in the Department of Information and Computer Sciences. He is also completing a Masters thesis in Learning Disabilities at San Jose State.*



To prepare students to visualize the same concepts they learn in mathematics and science courses, Northrop University developed a graphics tutorial program. Instead of separating symbolic information and image information, it encourages students to go from one form of reasoning to another.

The Real Robotic Revolution



During the planning stage of Northrop University's robotics center, Dr. Gruver spoke with Dr. Robert Canady, Dean of the Faculty, Northrop University, about the needs of industry which education can help answer.

What is the major stumbling block to automation?
The real problem facing industry is how to integrate the systems: how to take robots, computers, and sensors and put them all together in a manufacturing process.

Robots, when you first buy them, are very primitive devices. They are basically a mechanical hand. That hand can not touch, can not see, and can not feel. It has absolutely no sensory perception of the outside world. Part of the job we have to do is outfit it with the capability to think and process information.

What kind of advances are being made in this area of robot intelligence?
Most robots use fairly primitive computers. Even the LSI-11, which is one of the most advanced being used, is about four or five years old. There have been tremendous advances in the last two years. Advanced control systems and languages now make use of the 16 and 32 bit computers. This is relatively new in the robot area. They will now be able to process information faster and in greater quantities. That means you can have more complete models of the environment and you can do processing of sensory information such as inputs of vision and force that enable the robot to see and feel.

What is the real significance of sensory input for robots?
It allows the robot to become more flexible, to interact with its environment. A robot is normally positioned in one place. The part it is to handle is also positioned very accurately in one place. The robot is always taught to go to that point in the place. Now what happens if suddenly one day the robot is moved slightly, or the part is not in its place? The robot is going to come plunking down and miss the part. It may bang its gripper or destroy itself. The new sensory devices allow the robot to accommodate disorder or change in the environment. You are able to have parts come in at random locations and orientations in different orders.

This is really the whole idea of flexible manufacturing. Companies do not always need 100,000 parts of one type. They may need 50 of this part on one day and 50 of another on the next day. Sensory intelligence in robotic systems allows true flexible manufacturing that can switch from one type of product to another with very few changes in programming.

What will this do for the manufacturing industry?
Flexible manufacturing will allow companies to deal with the true demands of their buyers. It will eliminate a lot of warehousing and inventory. This is a major cost savings to industry particularly in aerospace where different parts of the project are job shopped. These are the small, high precision runs that are totally unsuited for robots at this time.

Which industries have robots entered so far and which are next?
Aerospace will be one of the hardest industries for robots to crack. Up to now, spot welding by robots has been solved. Detroit is full of robots that do spot welding for ten dollars an hour instead of $20 or $30 an hour for skilled labor.

Interview with William A. Gruver, Logistics Technology International, Ltd.



Robert Canady (right) and William Gruver at Northrop University

Assembly will be the next area for robotics. Material handling by robot is fairly well understood and should follow assembly.

After that, the next robot job will be machine loading, how to load lathes and milling machines and grinding machines with parts. A few manufacturers like Machine Intelligence, and Automatics, and OCTEC are developing vision sensors for the grinding tool which will allow it to see where the metal needs to be deburred. There are even companies marketing floor sensors for robots. But there is no large scale effort to put all these products together in a working system.

So, robotics is more than intelligent machines?

Exactly, it's a system of individual parts working together in a larger process. The manufacturers of robots are not equipped to handle the demand for integrating the different systems in, for instance, an assembly process.

Robots, computers and sensors have to be integrated in a working system. The first thing you have to do is build a hand for the robot. The hand is a custom tool and you can not just go out to the local robot store and buy a hand for every robot. There are a few general designs, but they will probably not work for your specific application. So, you have to go to a systems house and have them design it from scratch. Then, the interfacing of the robot to all your machines is another custom job. So, if you have $200,000 in an average work cell, maybe $100,000 of that is for the robot, $50,000 is for equipment and another $50,000 is for the services of integrating. As you start to get larger systems with multiple robots, a much larger percentage of the total cost is in the services.

What is the main concern of management when they consider automating their factory?

Cost. Right now, unfortunately the American management feels that it has to have a one year payback. By contrast, I have seen that the Japanese are willing to accept a five year payback or more. Long term investment is their rationale. They do not look at the short term because they know they are going to be around in five years. Our managers realize they are going to either retire or get canned within a year or two. They are concerned with getting the product out, not with making sure the company is in business five years from now.

You have done consulting work in Japan. How would you compare the American and Japanese production systems?

The Japanese claim they have 50,000 robots, but it is much smaller than that because their robots are more primitive than you could ever imagine. First of all, they do not even look like a robot. They just look like a gadget moving back and forth transferring material. This kind of automation depends on parts being in their proper orientation, position and at the right time. It is a kind of automation very well suited to handling very large product runs, but not capable of dealing with any disorder or variations in the product. They have a very good system of automation, but it is not always flexible automation.

How can the academic world help in the transition to automation?

As chairman elect and presently vice chairman of Robotics International, a professional society and branch of the Society of Manufacturing Engineers, I am part of the primary force in coordinating information sharing between industry and the universities. Through better cooperation with professional societies, universities will be able to help retrain labor for the new positions. More importantly, the universities will have to change their centralized concept of education. Departmentalized majors are very restrictive to learning. A person does not have to get a degree in electrical engineering to understand flexible automation.

Robots consist of mechanical systems, electrical systems, management systems, industrial systems, economics and almost everything else offered in a university. ***Just to train an electrical engineer will not make a robot engineer.*** It might make a robot designer or a systems designer who would only be able to handle a part of the process.

So, the universities are going to fall flat unless they get the idea of inter-disciplinary research and education very quickly.

I can not say it too strongly. Manufacturing and the Universities must increase cooperation and interaction.



Illustration by Cheryl Kline



ÆRO-EXEC

The future leaders in aerospace

The American aerospace industry is shifting its sights in the selection of future leaders.

The next captains of industry will demonstrate a different set of skills.

by Wesley Niemond

The cause of this shift, to put it bluntly, is the decline of American industry's productivity. Some may argue over the rate and degree of decline, but no one can argue with the fact that U.S. productivity has been declining, while the productivity of certain other nations has been on the increase. Cost contamination, product quality and delivery schedule problems are much more in the foreground today than uniqueness of design or superiority of performance. The disciplines of manufacturing engineering, manufacturing technology and quality engineering are being recognized as equally important — if not more important — than research and development engineering. Overall, macro-financial prowess is giving way to technical pricing skill. Traditional, aggressive sales and marketing expertise is being pushed to the background by the talent to put thoughts into action through strategic planning — the long-range goal setting that truly positions the company for the actual markets of the future.

Twenty-five years ago, the paramount objective of American industry was to develop greater demands for its products, so that factories would be filled to capacity with orders. This generated a marketing and sales orientation, which meant that a company's board of directors promoted executives with marketing, finance or legal backgrounds into senior corporate positions. This became known as the "manage by the numbers and sell regardless of producibility" syndrome. Then, as it became more and more difficult to move the merchandise, so to speak, industry moved into the development or acquisition of new products. Along the way, product fabrication was taken for granted. Manufacturing expertise was not considered particularly crucial to an industry's success.

The United States no longer produces the only product, whether it be commercial electronics, industrial automation equipment, or weapon systems. Today, faced with sky-rocketing manufacturing costs and product quality on the skids, we are witnessing the development of major competitive forces in Europe and Japan. And, within the U.S., there is increasing demand for lower-priced, higher-quality products, such as more cost-effective weapon systems.

The aerospace executive of the future is going to have to direct himself through a much different course than his predecessor in order to be considered qualified to handle the general management responsibilities of a significant, fully integrated, profit-and-loss, manufactured-product, business entity.

Over the past ten years we have seen, a shift in emphasis on the backgrounds and credentials of those who are candidates for general management, chief operating officer and chief executive officer positions. In years gone by, selection criteria often shifted like the changing winds, depending largely on the whim of a specific industry, or company, at a particular point in time.

"The executive of the future will have direct experience in the problems of producing quality products on time and within cost using new flexible manufacturing processes and materials."

For the past year or two, however, such winds have become much less capricious, and the selection process has grown correspondingly steadier. The call has gone out for someone who can assure that a product will be developed within the necessary timeframe and cost, and who knows what it would take to produce a reliable product at a desired rate — one who has experienced the craziness associated with shipping all monthly quotas during the last four days of the month. It takes a special breed of cat to take the reins of an aircraft company with 256 undeliverable airplanes in inventory and still maintain some semblance of credibility in the marketplace.

The people selecting the top executive seek an individual who is visionary and innovative and possesses some degree of charisma, enabling him to be highly influential without having to force the issue. The selectors also look for responsiveness to the needs of the company and the candidate's ability to make decisions on his own, quickly. If he can do this through some miraculous process, all the better. If he can't, he should at least be a good listener.

Career Planning

Although the people who are in a position to select general managers may not state it openly, they definitely look for an individual who has consciously positioned himself for the next move up the ladder. Sometimes this involves a little diplomatic politicking — which is not, to my knowledge, taught in any universities at the present — although it probably should be.

Credentials and Experience — Technical Know-How

The would-be executive should have solid exposure to both favorable and unfavorable profit and loss circumstances. And, in the case of the high technology aerospace business, the selectors have been looking for quite some time for an individual with an undergraduate degree in engineering, coupled with a masters degree in business administration or industrial management.

There are a number of aerospace companies that have made it a point to provide fellowships to promising young executives, who are sent away fulltime to obtain master's level degrees in business and management at specifically selected schools. Those executives who have this prestigious training are given an edge over those who don't.

A heavily weighted credential is one called the "track record of customer interface." Translated into English, that means being respected by – and communicating well with – influential members of the Department of Defense, NASA, the Department of Transportation and House Appropriations Committee. This is an essential element that must exist in a top aerospace executive's portfolio.

Looking for Scar Tissue

The top executive of the future will most likely, at some point in his career, have gone through the program management concept, from design and development all the way through prototyping and into production. The selectors will be looking for scar tissue left on his corporeal self by prime contractors, officials of the Department of Defense, the Congress, sub-contractors, managers, and — last, but not least, — any one of the devilish, incorrigible members of his matrix team.

Capturing the High Ground

The candidate will have to show evidence of a keen sense of strategic planning. To be a visionary and an entrepreneur is one thing, but to express it clearly and meaningfully in a strategic plan, with specific policies and guidelines, is something that has been left to the so-called professional strategic planners. The executive of the future is actually going to have to do this kind of planning himself, through the use of computers and a little midnight oil.

Recently, a successful program-management executive of one of the leading aircraft firms in the country said that part of his company's strategic plan was to position the firm for the next prime, tactical aircraft procurement. Accordingly, the company has, for the past five years, been bidding on only those research and development contracts (and assigning internal investments funds to those development activities) that would lead to an advanced technological advantage over its competitors. The guidelines in the plan were extremely clear as to what to do, what *not* to do, and how to specifically go about it. As a result, the win rate for this particular company was stated as being 92% of everything bid on, and 100% in the direction of capturing the high ground.

Product Pricing

The new aerospace executive with a difference will have an almost innate genius for pricing all phases of a program or product, from design and development to prototype, through test, and into rate production. Going hand-in-hand with this will be his unmatched ability to negotiate a contract. This does not mean that he will personally do it, but that he will know exactly how it should be *done.* He'll know exactly how to price the development cost because he'll know what to ask for, and will grind his specialists down until the hard core of truth is exposed about every element that goes into the development cost. And then he will be able to instruct his negotiators as to what they can say and what they can't say, what they can trade *quid pro quo*, how and when to yield to certain demands and still remain standing on a firm financial platform. Experience in negotiating with Boeing on a subcontract, or with the Navy when they don't have any money or with a prime contractor who is dealing *with* that same Navy — might be looked upon as outstanding proficiency training.

Industrial Modernization

U.S. companies that are competing on both a domestic and worldwide scale must be well into an industrial modernization program right now if they intend to exist five to seven years hence. Therefore, the top aerospace executive of the future must either have had experience in, or have to be tutored in, technological aspects of the Factory of the Future.

Vought Corporation, in Dallas, Texas, is taking its first steps toward the Factory of the Future through its industrial modernization organization (IMOD).

Vought's goal is to move a Batch Operation to a Serial Operation, reduce the work in process, and improve output from 21 days to a matter of hours through the flexible Machining Cell concept.

Traditional approaches to manufacturing will not begin to solve the problems of high production costs and inefficiencies. It has been stated that material moving through a metal-working plant spends up to 95% of total time in storage or queue. "After we streamline the work flow," sources at Vought say, "we should look toward replacing the entire Material Department with computers."

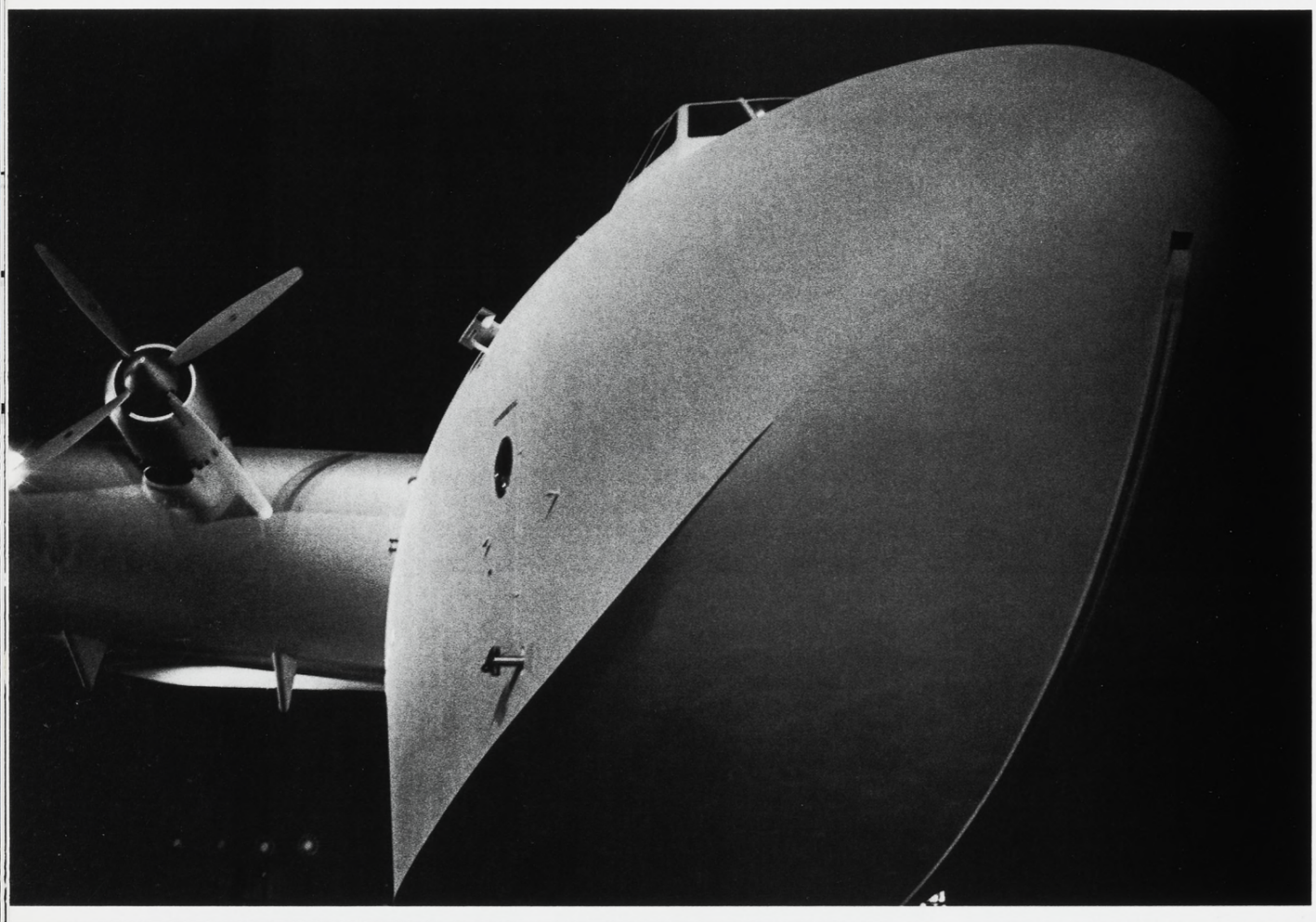
In the material sciences area, Vought has been developing advanced carbon/carbon, high temperature woven/laminated structural materials that grow stronger at higher temperatures. They are also exploring new, top secret ways for providing oxidation protection for these structures which are used on the space shuttle, rocket nozzles, missile turbine engines and jet engine after sections. Manufacturing is keeping up with ceramic materials development.

Another example of the trend toward the Factory of the Future might be what Northrop Corporation is doing in the use of robotics for the lamination and testing of advanced graphite composite materials. They are also using robotics in the product quality area. The executive of the future will have direct experience in the problems of producing quality products on time and within cost using new flexible manufacturing processes and materials.

Worldwide Decision Making

The top aerospace executive of the future must be able to think and make decisions on a worldwide marketing basis. He must be able to recognize what is being done to him on a global scale by his competitors, and what market opportunities can be afforded him either through his existing products or through the development or acquisition of new products. He must be able to develop the necessary skills in dealing with members of foreign governments, multi-national corporations and industrial enterprises within these foreign governments, including dealing with third-party negotiators. Thinking on a global scale does not mean perpetually flying around the world in an airplane. What it really means is developing a worldwide intelligence and communications systems that will allow global decisions to be made on a realtime basis.

***Wesley Niemond,** a partner of Finnegan and White, Inc., Los Angeles, specializes in executive search for the aerospace industry. He received his Bachelor of Science from Northrop University in 1950 in Aeronautical Engineering.*



The Grey Ghost

A Photo Essay on the Hughes Flying Boat



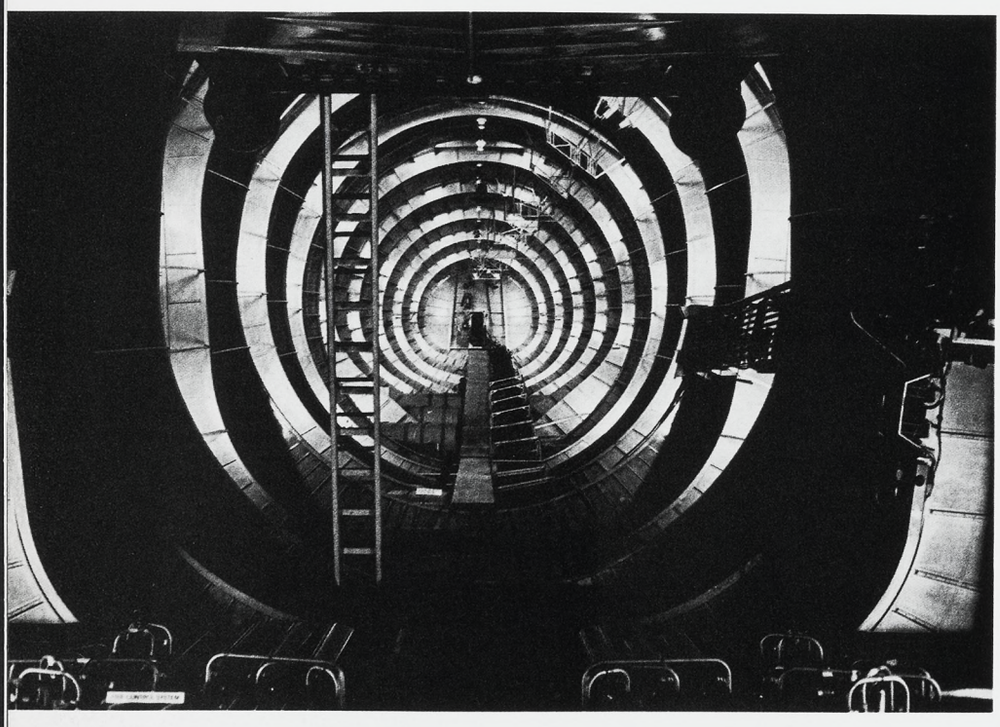
Photographs by Chauncey D. Bayes

For over a quarter of a century, the world's largest airplane remained a well-guarded secret. Ever since its first and only flight in 1947, the Hughes Flying Boat was secluded in a massive humidity controlled hanger in the Long Beach Harbor and maintained in mint condition under 24-hour guard.

Howard Hughes wanted the 200-ton aircraft kept alive and operational. Three hundred workers were hired to coddle the aircraft, add an auxiliary hydraulic system, new throttles, new engines and redundant back-up electrical systems. The eight Pratt & Whitney 3000 horsepower engines were run on a regular schedule of weekly operation, as were the flight controls and support systems. Modifications and repairs were continuous for over twenty years. The promise of a second flight was kept as alive as the aircraft. Even a year after Howard Hughes died, the Armed Services and NASA concluded in a six-month study that the 30-year old Flying Boat was still flyable. As the only giant seaplane in existence, it was of great interest to the Navy, but not as an immediate priority. So in 1977, Summa Corporation decided to turn off the air-conditioned, humidity-controlled support system in the Terminal Island hanger. Hopes for any future flight of the Flying Boat were officially dead. It was only a matter of finding the right museum setting for a final resting place.

Today, under the ownership of the Aero Club of Southern California and the management of the Wrather Corporation, the Hughes Flying Boat stands on public display in the middle of the world's largest geodesic dome structure next to the Queen Mary in Long Beach, California. Surrounded by a moat of water and flooded with light, the H-4 Hercules makes a ghostly appearance as a monument to aviation, perfectly preserved and still ready to fly.

It was to be the largest cargo plane ever built, a flying boat for massive troop and tank transport across the submarine-infested Atlantic during World War II. According to the government contract with Henry J. Kaiser and Howard Hughes, the flying boat would be constructed entirely of

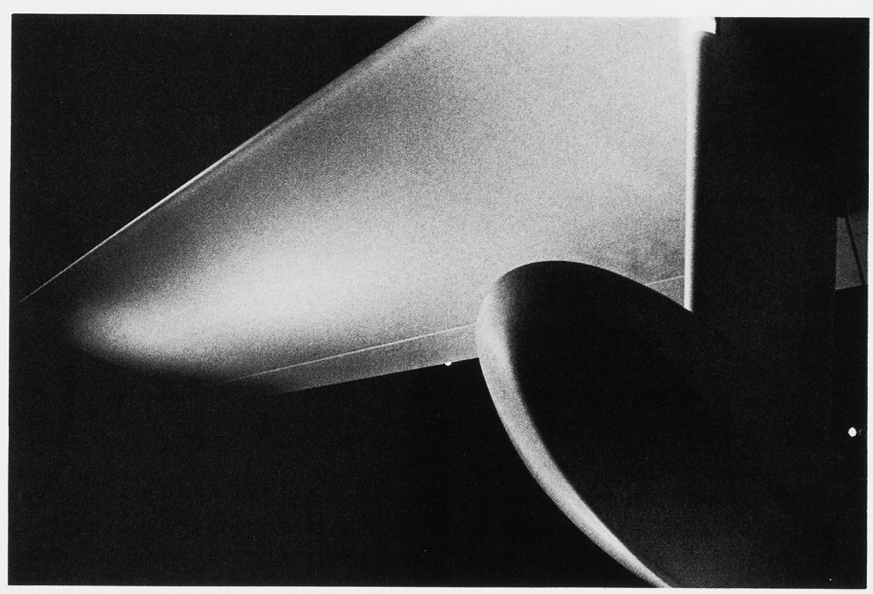


wood, a non-strategic material, and bonded by a new Duramold process.

Like a modern Noah's Ark, the 200-ton flying boat was designed to carry a payload of 130,000 pounds and to hold 14,000 gallons of fuel. Hughes was determined to design and fly an aircraft with a gross weight of 400,000 pounds. The floor of the boat would support 125 pounds per square foot, a strength sufficient to allow an 80-ton Sherman tank to roll into the cargo hold fully assembled. Between the cargo deck and the floor of the hull were 18 watertight compartments designed to allow complete flooding of 12 and still keep the seaplane afloat.

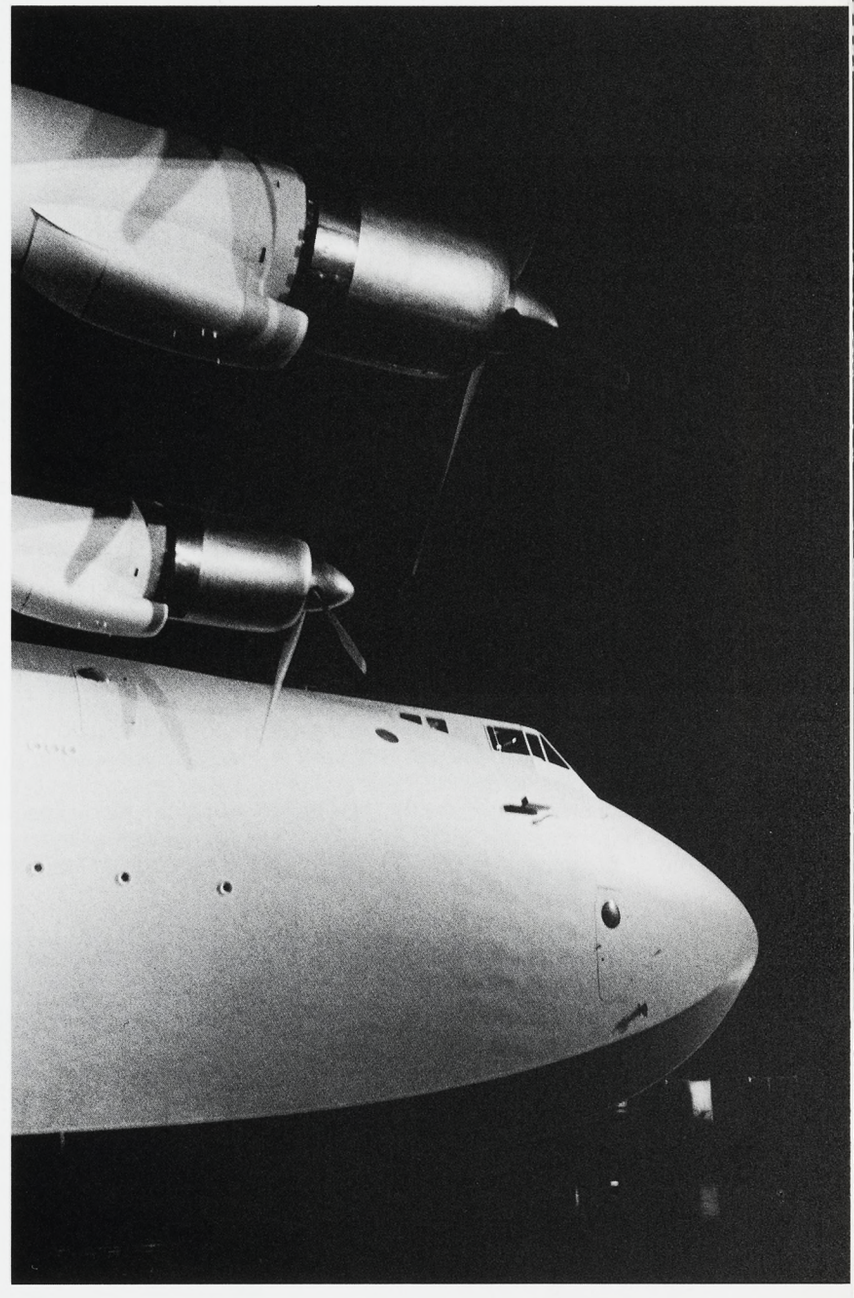
Hughes explained the magnitude of problems involved in building a 200-ton wooden flying boat in his testimony before a senate investigation committee shortly before testing the aircraft in 1947: "Now this airplane," he said, "has crossed a barrier in size. That barrier I consider to be one where the control system can no longer be operated by a man, even in emergency. Up to this time we have had airplanes which involved a booster system, like the boost on your brake in an automobile, just to make controls easier to operate. But if that system ever failed, the pilot was still able to operate the controls manually in an emergency, and I believe sincerely that this is the first time an airplane has ever been designed or built which was so large that no man could ever possibly work the controls under any circumstances. So, the flight of this airplane must depend completely on the power system of those controls." (In U.S. Congress, Senate Special Committee to Investigate the National Defense Hearings, 1947.)

Due to the innovations required for building a massive aircraft out of wood, it was not possible to complete the project in time to be of military value. By 1944, the war production of airplanes was slowing down. After investing



$18,000,000 in the Flying Boat, the government cancelled further support. Kaiser withdrew from the project and Hughes was left to support the completion and assembly of the aircraft. He devoted 18 to 20 hours a day to the plane for nearly three years, financing the development of a unique 120 volt DC three wire system to reduce the electrical system's weight by 75%, and pioneering a new plywood bonding process for the 3-ply birch skin of the Flying Boat. Teams of engineers worked to perfect the electrically driven, hydraulic pumps which could operate telecontrol systems within a 1/300 of a second response time, as well as an artificial "feel" system in the yoke to give the pilot a sense of power-steering for the 400,000 pound gross weight aircraft. By 1947, the many experiments in craftsmanship and engineering were ready to be tested. The monumental aircraft would have to fly.

For Hughes, the aviator, any success could only be measured by flight performance. In a moment of scientific bravado and showmanship, Howard Hughes taxied the world's largest airplane through the Long Beach Harbor gradually increasing its speed to seventy knots when suddenly, to the surprise of the crowds on shore and the 26 people aboard, the 200,000 ton aircraft lifted off the water and rose to an altitude of 85 feet where it cruised for over one mile. That short feat qualified the monumental aircraft to enter the historic tradition which began with the Kitty Hawk, the tradition of giant first steps in aviation.



STANDING GUARD

Stan Soderberg keeps the legendary Spruce Goose alive for 37 years.

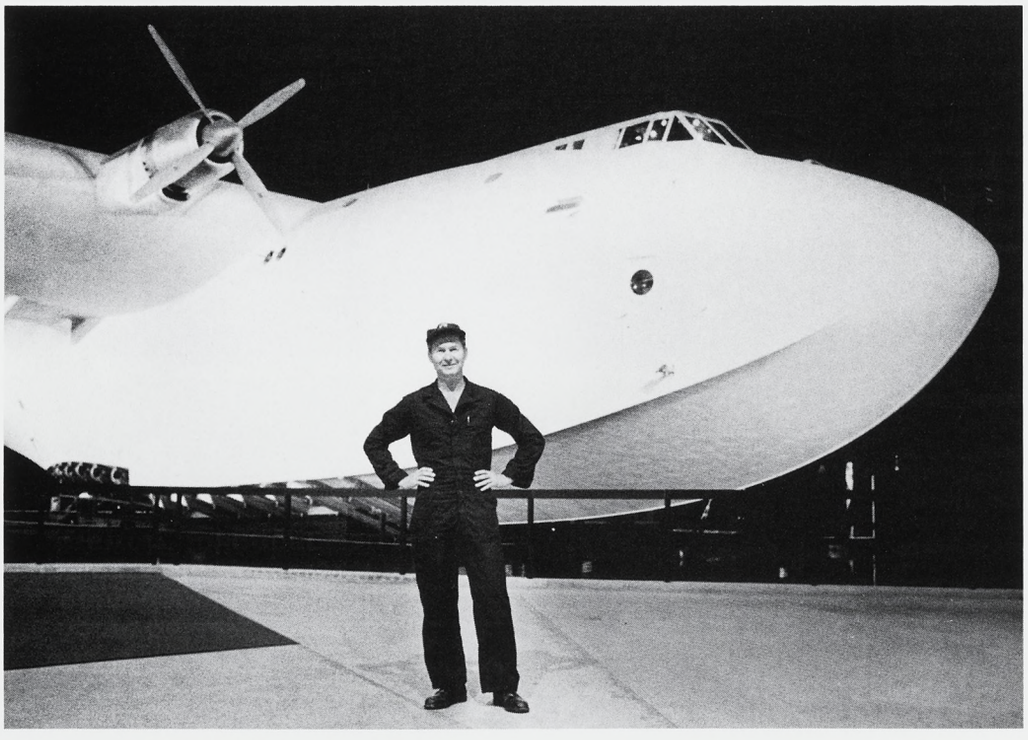
He tells the story with a certain sense of mystery. "It was fate or the Good Lord, or whatever you believe in, but it was meant to be," said Stan Soderberg after working on the Spruce Goose, the Hughes' H-4 Hercules, for over 37 years. "I'm the only one who was with it prior to the flight, and who is still with it now," he smiles.

That wasn't the way he planned it. After World War II, Soderberg found himself working for Hughes Aircraft at $1.19 per hour repairing the LODESTAR, the same airplane Hughes had flown around the world in 1938. Soon he was transferred to a one-month job stitching Irish-linen coverings for the vertical stabilizer on the Spruce Goose. He had no idea that was just the beginning of the vigil for the ex-Navy parachute rigger, aerial combat gunner, and champion gymnast who would spend the next 37 years learning everything there was to know about the Hughes Flying Boat. From the pre-flight preparations in 1947 through the post-flight maintenance and modification of the aircraft, which continued in guarded secrecy for 20 years, Stan Soderberg remained. Today he is the only person with a lifetime, first-hand knowledge of the historic aircraft.

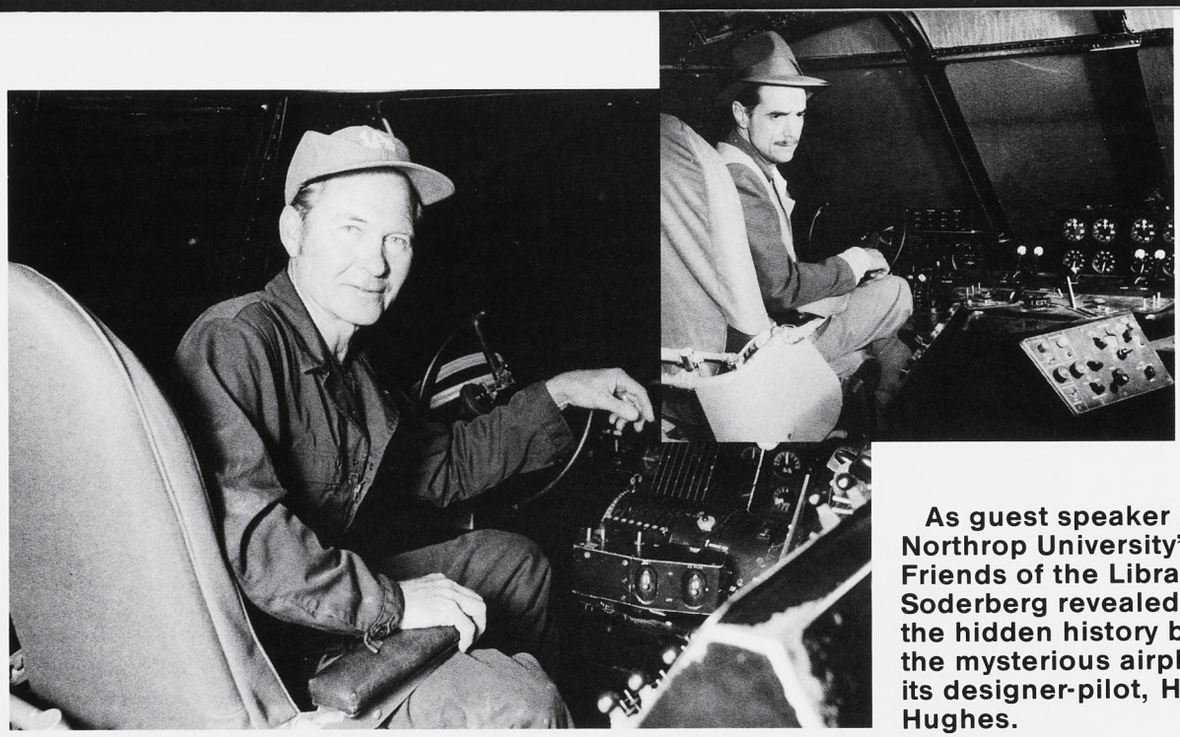
During your years working on the Flying Boat, were you able to get to know Mr. Hughes?

Since I was working the night shift from 3:30 p.m. to midnight, and Mr. Hughes was a night-time person, I got to see a lot of him. He was very congenial, but when he was around the aircraft, he was all business. He would come down to run the engines and check the instrumentation almost every night.

I guess the first time I saw him was in early 1947. He was still recovering from the near fatal crash when the counter-rotating props on two engines of the F-11 reversed in mid-flight. The plane went down, hit a house in Beverly Hills and was totally demolished. Hughes crushed a lung and was so badly burned that the doctors told upper management at Hughes Aircraft they didn't think he would make it through the night. Thirty days after the crash, he walked out of that hospital, went to work on the second F-11, this time



". . . when you consider that the Wright Brothers only flew the Kitty Hawk for a distance of half one wing span of the Hughes' Flying Boat, then the mile or so that Hughes flew the world's largest airplane was enough to prove his point."



As guest speaker for Northrop University's Friends of the Library, Stan Soderberg revealed much of the hidden history behind the mysterious airplane and its designer-pilot, Howard Hughes.

with single rotation props, which he finally built and flew successfully just a few months before he came down and flew this giant Flying Boat.

What did you think about him personally?

Well, I thought for sure he wasn't 'psyched out' by crashes. He really went through quite a few that would have killed the average person. At the time I knew him, he had a big heart with a zest and will to live.

I remember when he crashed in his racer, he was going 367 mph on the final run when it just quit dead. He made a perfect belly landing and skidded to a stop. By the time the crash crew got to him, he was out sitting on top of the airplane with a big grin on his face.

What did Hughes personally do on the flying boat besides test the engines and instrumentation?

Hughes had everything to do with this airplane. From the ideas to the final approval and even the painting, he was totally involved. It was his airplane. A lot you see here on the flight deck were improvements made solely by Hughes. On the day of the flight it had only four throttles, one for every two engines. Now it has eight. They were pneumatic at the time of the flight and the response wasn't to Hughes' liking. So he had servos put in all eight of the engines on the throttles and the response is now 1/300 of a second. Hughes also developed an "artificial feel system" in the yoke which would give Hughes the feeling he was flying a conventional airplane.

Did you know he was going to take the flying boat out and actually fly it in 1947?

According to all the publicity and advertising, it wasn't supposed to fly, but I have my own thoughts on that.

Why wasn't it supposed to fly?

You never take a plane out the first time and fly it. Even with the F-11, he made a lot of runs up and down the field just taxiing, before he ever flew it. Now, especially with an airplane like the Flying Boat with all the unknown factors of a first-time aircraft, you don't just taxi and take off.

Why do you think he did it?

I think in the back of his mind he knew it was the right time to fly the plane. He was under fire from the Senate Investigating Committee and he had a lot to prove. Besides, he had publicly announced that if the plane didn't fly, he was going to leave the country.

But, I know he was not going to jeopardize the lives of 26 people on board just to prove the plane would fly. Obviously, after he had taxied around the harbor a couple of times, he felt the plane was ready. In fact, he said later that with those huge flaps in take-off position at fifteen degrees, he could feel so much buoyancy that he just lifted it off. But I think everybody was suprised at how quickly it just rose up at seventy knots.

Why didn't he fly it higher or further?

He had about 8,000 gallons of fuel on board when she flew, so Hughes could have gone up to San Francisco and back several times. But sitting up there in that pilot's seat, he could see those 26 passengers just milling around the flight deck near the opening to the stairwell down to the belly of the aircraft. With a sudden turn or a rough landing, anyone could have fallen down that stairwell and been killed. Hughes wasn't going to risk more lawsuits and investigations. Besides, when you consider that the Wright Brothers only flew the Kitty Hawk for a distance of half one wing span of the Hughes' Flying Boat, then the mile or so that Hughes flew the world's largest airplane was enough to prove his point.

What kind of state do you keep the plane in?

It's detrimental to the airplane if it is not kept in good running condition. The engines used to be maintained on a weekly basis. Today we use a preservative oil and as you can see through that engine's cylinder wall, the engine is in a perfect state, perfectly preserved. All we would have to do is replace some rubber goods, flush it out, crank it up, and away it would go. We'll keep it like that. Even the spare parts are practically pickled and then sealed with a plastic covering. You could probably throw those spare parts in the ocean and they would still be usable after 100 years.

Do you actually mean those engines would still run if you started them up today?

They sure would. But, of course, if we started them up now, they would blow the top of this dome structure clear off.



Northrop University's Balloon Crew from the Lighter-than-Air program provided launch and ground crew support for the flight of the official U.S. Bicentennial Balloon FREEDOM.



Celebrating FLIGHT



On November 21, 1783, the French balloonist, Etienne de Montgolfier, made the first manned flight in history when he soared over Paris in a hot air balloon. Sailing for 25 minutes, Montgolfier travelled the first five and one-half miles by air.

One year later, in 1784, a Maryland lawyer launched the first successful U.S. balloon piloted by 13 year-old Edward Warren, making June 24, 1784 the beginning of all U.S. air and space exploration.

Test pilot Scott Crossfield Northrop University President B.J. Shell and STS-4 pilot, Ken Mattingly arrive at the helipad of the L.A. Airport Hilton.



Throughout 1983 and 1984, the United States and allied nations are commemorating the science, technology and enterprise of flight. Recognizing its historic role as hub of the aircraft and aviation industries, the City of Los Angeles joined the national Bicentennial celebration by inviting participation from aviation greats, aerospace, and high technology industries in a four day exhibit at the new Los Angeles Airport Hilton.

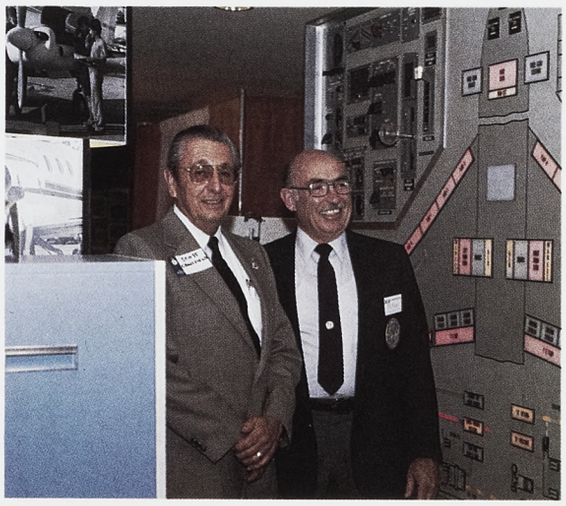


Photo: Rodney Watkins

Scott Crossfield, X-15 pilot, at the Aviation Technician School exhibit with Joe Hamm (right).

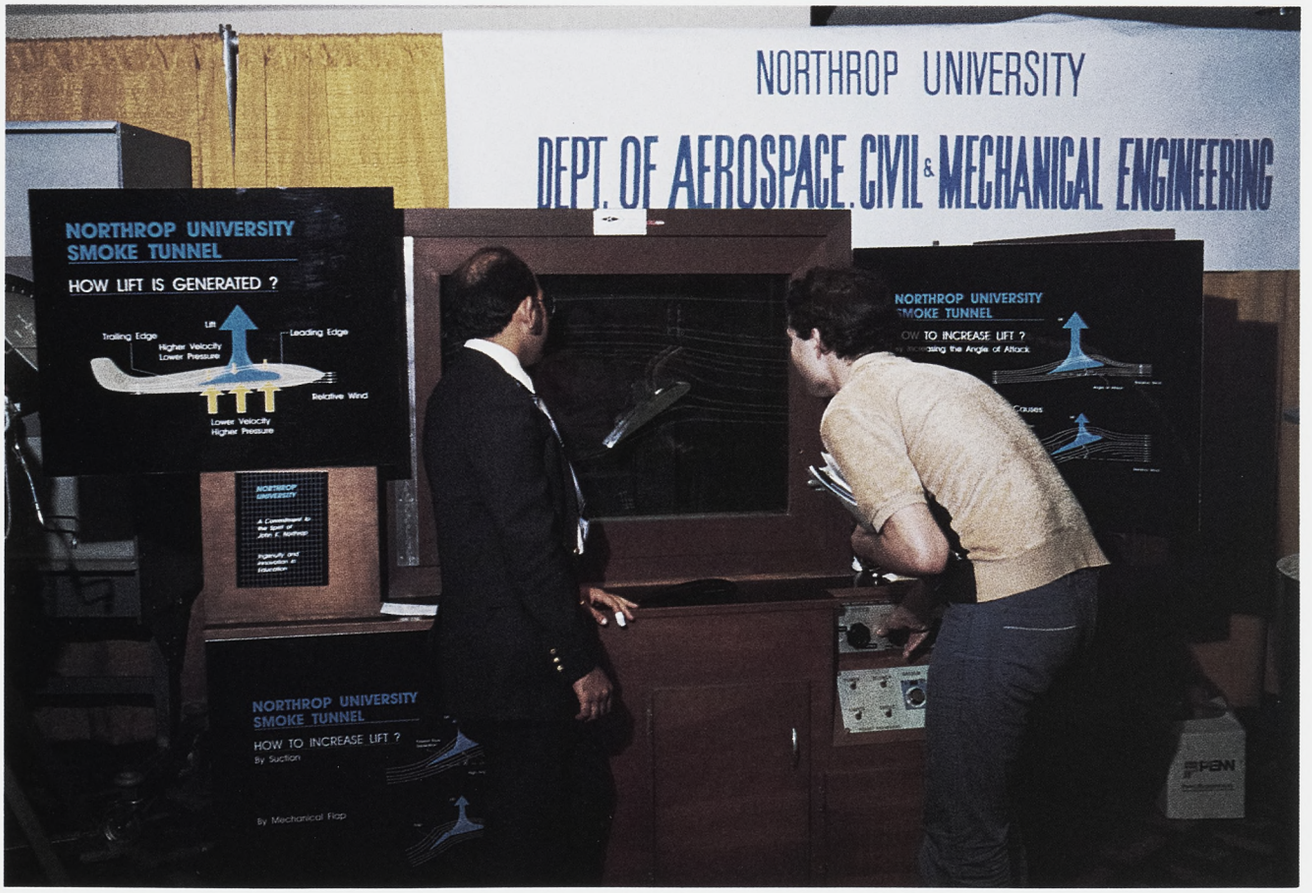
Stealing the show from Barron Hilton and Los Angeles Mayor Tom Bradley, Northrop University's performance robot, EDDIE, cut the ribbon as Master of Ceremony at the L.A. Salute to the Bicentennial.



Northrop University was selected to represent education in the science and technology of flight. Top honor students in engineering and technical societies were invited to welcome aviation greats 'Jimmie' Doolittle, the first to fly 'blind' with instruments; Ken Mattingly, the STS-4 pilot; and Scott Crossfield, the X-15 test pilot holding world speed and altitude records.



Caught up in the spirit of aviation and flying the banner, "Ingenuity and Innovation in Education," crews of students, alumni, and faculty managed in just 42 days to design, materialize, and move what they considered the essence of each university department to the Airport Hilton Conference Center.



Dedicating their exhibit to the spirit of John K. Northrop, student volunteers took turns demonstrating new robotics technology, smoke tunnel basics, computer teaching games and graphics. The Aviation Technician School even brought its 727 hydraulic systems control panel as well as the school's pride, a perfectly maintained and airworthy OX-5 Curtiss, the historic 'Flying Jenny' engine.

Within four days, the aviation and aerospace communities managed to transform an exhibit into a celebration of balloons, test pilots, aviation history and plane enthusiasm, demonstrating the true nature of the spirit behind 200 years of flight.



ROBOTICS:

Myth & Reality

The concept of robotics has captured men's imagination for centuries. Since 300 B.C. man has experimented with automated animals and human figures for the entertainment of kings and nobles. Ernest R. Hall recounts in the Fall '83 issue of *Tau Beta Pi*, the story of man's fascination with robots in the article "Getting a Grip on Robotics:"

In 1921, the word robot was coined by Karl Capek, a Czech playwright, novelist and essayist in his satirical drama RUR (Rossum's Universal Robots). In the play, Rossum and his son manufacture machinelike humans of super-human strength and sub-human intelligence as a replacement for the human workforce in the hope that the robot would perform obediently in the service of man. Later in the 1940's, science fiction writer Isaac Asimov wrote a series of robotic stories that portrayed the robot in a happier light. Asimov developed the Three Laws of Robotics which remain worthy design standards:

David P. Aldrich

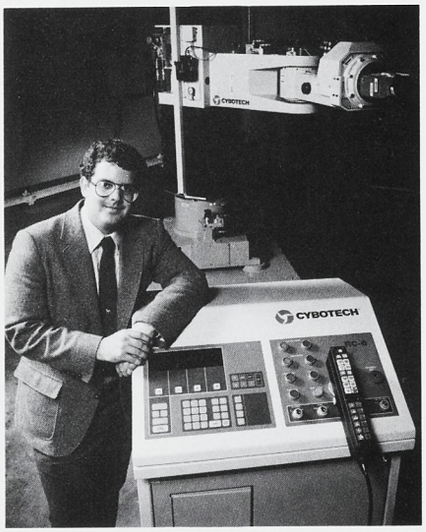
1. A robot must not harm a human being, nor through action allow one to come to harm.
2. A robot must always obey human beings, unless that is in conflict with the first law.
3. A robot must protect itself from harm, unless that is in conflict with the first or second laws.

Today, thanks to Capek and a generation of science fiction writers, everyone thinks that a robot is a mysterious electro-mechanical intelligent human-like machine — be it good or evil — that can save man from the clutches of evil or is capable of destroying the human race.

The fact is that this mythic image still prevails today as illustrated by R2D2 or C3PO in the 1977 movie, "Star Wars".

What is a robot?

The most common robot of 1983 is a pillar-mounted, multi-jointed arm that moves mechanically on command from a computer, usually lacking visual or tactile sensory perception. It follows blindly a preprogrammed series of motions no faster than a human worker. Unless the workpiece arrives at the exact location and orientation, the robot will fail. This is better known as "the Industrial Robot".



***David P. Aldrich** is coordinator of Automated Manufacturing Systems at Northrop University. He is also Chairman of the second "Robotics for Education Workshop" to be held at the University in August 1984. As certified Manufacturing Technologist with the Society of Manufacturing Engineers, Aldrich received the Educator of the Year Award for Chapter 27 Southern California.*

". . . the teaching of robotics by itself is incomplete. The entire workcell and related equipment must be taught."

The Robot Institute of America (RIA), a trade association of industrial robot manufacturers, defines the industrial robot as:
". . . a reprogrammable, multi-functional manipulator designed to move material, parts, tools, or specialized devices through various programmed motions for the performance of a variety of tasks."

Looking closer at the key words, we see that REPROGRAMMABLE implies that the robot is computer controlled; MULTIFUNCTIONAL implies versatility, and MANIPULATOR implies something that can do work.

Another definition that is growing in popularity with industry is the Soska Definition by Geary Soska of Cybotech Corporation which defines a robot as: *". . . a reprogrammable, computer-controlled machine that can be programmed to perform a variety of tasks normally accomplished by human beings and capable of being interfaced with its environment to interface intelligently with the equipment with which it is working, and able to adapt its operation within the overall process through the acquisition of sensory data."*

Current Usage of Robotics

The key element of the modern robotic applications is the removal of the human worker from menial, tedious, repetititive, dangerous and otherwise unpleasant jobs. Robots will displace the human from hazardous environments that include: ozone atmosphere generated in welding; chemical mists encountered in spray painting; problems in handling molten metals in foundry applications; lifting heavy or sharp objects in parts assembly; and reducing tedium in assembly line operations. As the technology improves in the software capabilities, vision systems, and sensory devices in robotics, so will the level of complexity of its application.

For the past decade the media has used the word "robot" as a buzzword. A popular national news magazine reports:". . . *"by 1990, over 150,000 industrial robots in the U.S. will COST MILLIONS OF BLUE-COLLAR WORKERS THEIR JOBS."* A consumer magazine claimed: *"The ROBOTIC REVOLUTION will create 800,000 new jobs by 1990."* An East Coast newspaper claimed: *"1.5 million robotics technicians will be needed by 1990."*

The above statements on industrial robots were from well-known experts. Their theoretical estimates were based on past industrial trends. The major problem encountered when dealing with robotics is the fact that the field is highly unpredictable. Little information has been collected concerning robotic's impact upon the manufacturing world until the 1982 Delphi Study conducted by the Society of Manufacturing Engineers (SME) and the University of Michigan. A more recent study requested by the State of Michigan of the W.E. UpJohn Institute of Employment Research of Kalamazoo, Michigan, studied job displacement, job creation, and training implications of robotics. The research was to focus on the State of Michigan and then the nation as a whole, forecasted to 1990. The findings have been published by H. Allan Hunt and Timothy L. Hunt within a book entitled *Human Resource Implications of Robotics.*

Let us look at the facts compared to the "myths". From several surveys conducted we know that there are approximately 6,800 to 7,000 installed robots within the United States mostly in the auto industry. The Robot Institute of America, formed in 1975 with a membership comprised of robot manufacturers, users, and research organizations, predicts that there will be 75,000 to 100,000 robots in U.S. factories by 1990.



An early introduction to Robotics: David Aldrich introduces HERO-1 to a Kindergarten class.

What is the robotic workforce?

Both the Delphi and UpJohn studies conclude that 100,000 to 200,000 jobs will be displaced by 1990, which roughly amounts to one job per robot per shift. In the automotive industry the job displacement in 1990 probably won't exceed 4-6% due to robotics. That's less than the industry's annual average turnover for retirement, death or voluntary leave.

The word "displace" does not mean instant unemployment. Those skilled workers will be retrained to operate the robotic system, or simply be shifted to another part of the factory where their skills would be needed. When robots enter the factory, they do so at a slow rate due to the high capital investment and the present level of manufacturing techniques used in industry today.

To predict a Robotic Revolution which will create 800,000 new jobs by 1990 is far from accurate. Today's auto industry in the United States has a workforce of less than 800,000 workers. What are the true projections of employment in robotics? The UpJohn Institute estimates between 32,000 and 64,000 new jobs will be created by robotics which includes robot and robot suppliers manufacturers, robot system engineering, and users. The future sale projections are estimated at two billion dollars in the year 1990 by the robotic industry's calculations. Compared to Chrysler's 1981 sales of 11 billion dollars and General Motors' sales of 50 billion dollars the same year, the robotic industry sales will be small.

Today within the entire United States, there are only approximately 1.25 million engineering and science technicians of all kinds. At the projection of 1.5 million robotic technicians needed by 1990, that would amount to 7.5 technicians per robot. From studies conducted, the estimates have been found that one technician for ten robots will be needed per shift, or 12,000 to 25,000 robotic technicians needed by 1990.

Up to this point, reference has only been made to the word "robot", a term that we now understand as a mechanical arm controlled by a computer. But the robot cannot function by itself. In the manufacturing world, when a robot is placed within an operation, we now call that operation 'automated.' In order for the robot to function to its fullest capacity, all fixtures, material handling devices, and machinery within the workcell must be designed to the same technology. Therefore, the teaching of robotics by itself is incomplete. The entire workcell and related equipment must be taught.

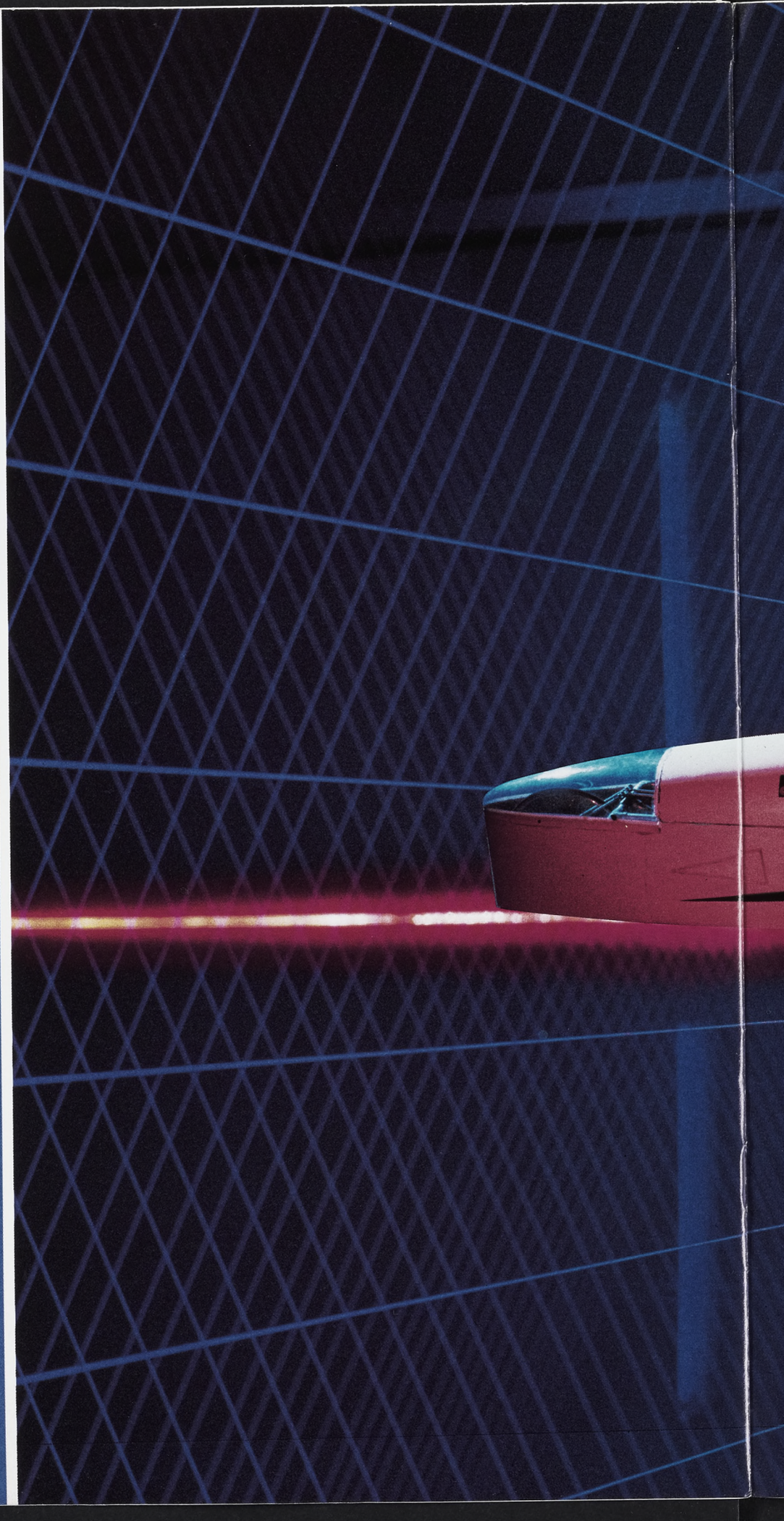
Through the joint efforts of Northrop University's Computer and Information Science Department and the Department of Engineering Technology, programs are being developed to educate those engineers in industry today who do not have a working knowledge of the automated manufacturing innovations. Even though robotics and automation are entering our factories at a slow pace, the future growth of the United States industries depends on this new technology.

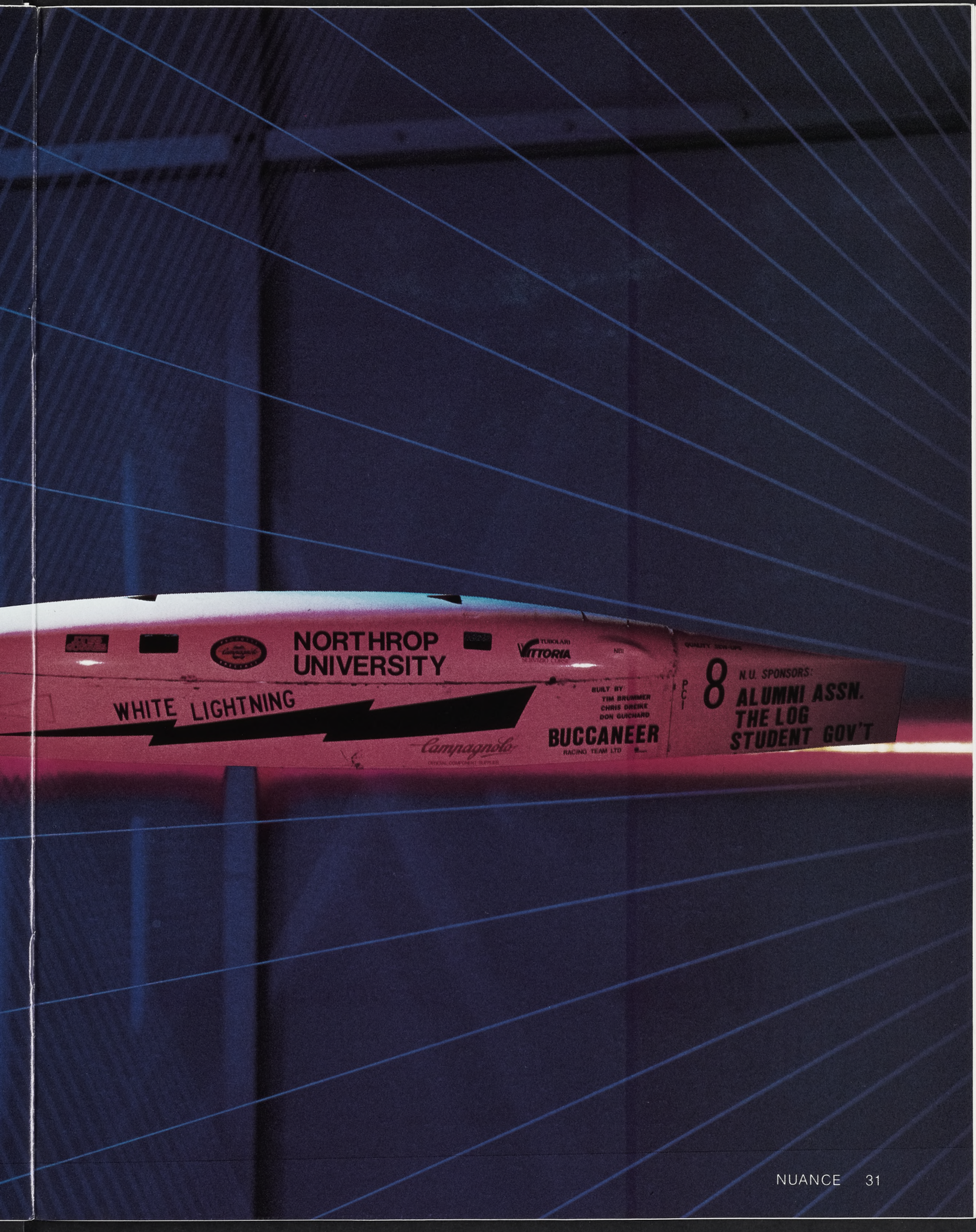
WHITE LIGHTNING

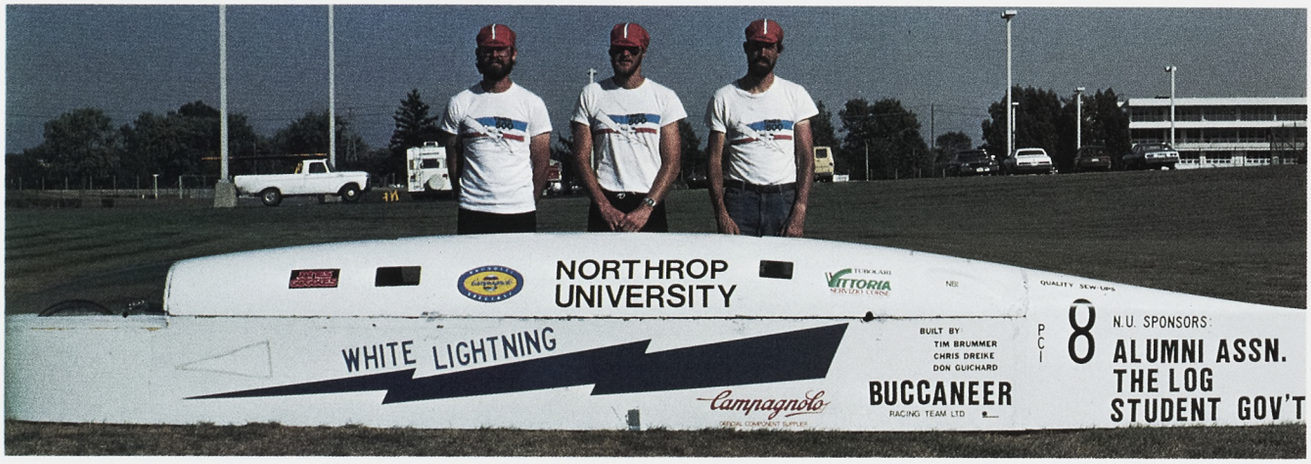
The aerodynamic supercycle built for two wins first place as fastest human-powered multiple-rider vehicle.

Streaking through the quarter mile 'flying start' at 55.9 mph, White Lightning captured the 1983 world title for fastest human-powered multiple-rider vehicle at the Indy 500. In its seven year racing career, White Lightning broke three landmark speed records as the first human-powered vehicle to exceed 50 mph, the first to break the federal speed limit of 55 mph, and the first to break the 60 mph barrier. The space-age cycle remains one of the lightest, fully-faired tandem vehicles in human-powered history and the only one to stretch its performance limit through seven years of successful competition racing.

Designed by Northrop University engineering students Tim Brummer, Chris Dreike, and Don Guichard, the innovative three-




NORTHROP
UNIVERSITY
WHITE LIGHTNING
TUBOLARI
VITTORIA
BUILT BY
TIM BRUMMER
CHRIS DREIKE
DON GUICHARD
BUCCANEER
RACING TEAM LTD
Campagnolo
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wheel aerocycle is part of an experiment to develop more efficient human-powered land vehicles. Propelled by sheer human athletics, the low-riding streamlined cycle is capable of flat road speeds of 62 mph, an increase of 20 mph over the world's fastest standard racing bicycle. Under the conservative rules of the Union Cycliste Internationale, the standard racing bicycle is not permitted to use any streamlining or aerodynamic modifications. A crouched-position racing cyclist would have to put out an impossible 6 hp to achieve 60 mph. Despite the proven benefits of aerodynamic streamlining, the Union Cycliste rules remain firm and the standard bicycle design remains unchallenged for seventy years.

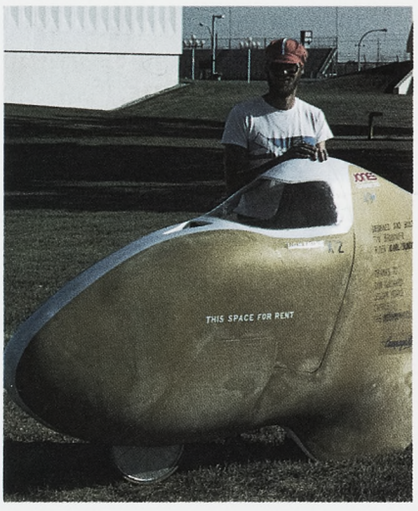
In 1976, a new age of bicycle engineering was officially inaugurated with the founding of the International Human-Powered Vehicle Association by Dr. Chester Kyle. Dedicated to the improvement of human-powered vehicle efficiency, the small group of cycle enthusiasts and design engineers introduced aerodynamic fairings, lightweight composite materials and low, reclining-rider or recumbent alternatives to the traditional bicycle design. With the application of aerodynamics to bicycle design, the International Human-Powered Vehicle Association continues a tradition as old as aircraft design itself, when bicycle manufacturers Wright and Curtiss both equipped experimental bicycles with wings and motors to test their airframe and engine designs.

White Lightning's winning edge in human-powered vehicle racing is its lightweight Epoxy fiberglass fairing with Nomex honeycomb core contoured to fit an airfoil shape with the reduced drag coefficient of only .1, less than one-quarter that of the average automobile. Tim Brummer, an aeronautical engineering student at Northrop University, developed the airfoil design through several models in wind-tunnel testing. He also determined the critical ground clearance distance of less than one inch to eliminate much of the ground interference drag. Chris Dreike, an electronic engineering major, customized the White LIghtning speedometer for an accuracy reading within one-tenth of a mile per hour. Don Guichard, a mechanical engineering student, designed the innovative front wheel steering which eliminates steering forks, increases stability at high speeds, and accommodates the streamlined, low-vehicle design. At twenty feet long, thirty inches high, and 29 inches wide, White Lightning's aluminum alloy frame, running gear, and fairing weigh only 75 pounds, making it one of the lightest fully-enclosed tandems in competition.

Not all multiple-rider vehicles were designed as effectively for stability, manueverability and speed. Limelighter vehicles like MIT's New Wave and Northeastern's Tensor were designed for a power-squadron of four or five cyclists, making their vehicles twice as long as the White Lightning. The 42 foot long New Wave required $20,000 and two years to build. Despite the time and money, it still tore the transmission chains from the gears at the 1982 Orange County Speedway, resulting in two cyclists riding as dead weight for a top speed of 40 mph. The 40 foot Tensor, with its fairing raised an uncomfortable 30 inches from the ground, never made it over 34 mph in the same race. White Lightning clocked the highest speed of the day with 52 mph. It was designed, tested, and built in seven months by three engineering students working nights and weekends to complete their last year of courses at Northrop University.

The White Lightning would remain competitive with only minor modifications and repairs for seven years, breaking three world records, and placing either first, second, or third in each competition it entered. That kind of vehicle engineering and long-term performance testing suggest a transfer point where human power becomes a function of human spirit.

As Delwin Dang, representative of the Northrop University Human-Powered Vehicle Club said, "We want to continue the spirit of the White Lightning. We plan to design, test, and build a prototype for the fastest single-rider human-powered vehicle in the world by September 1984." They intend to win the DuPont prize of $15,000 for the first single-rider, human-powered vehicle to break the 65 mph barrier.



Tim Brummer's X-2 also won the Indy 500 as the world's fastest single rider bicycle.

Flying on Foreign Currency?



The Fate of International Air Carriers

Charles Tillinghast, Jr.

Vice President
Merrill Lynch White Weld Capital Markets Group

The airline industry is an insatiable consumer of capital. During the decade from 1970 through 1979, the trunk and regional airlines of the United States spent about $25 billion on their capital needs. Of this, about $15 billion came from internally generated funds, primarily depreciation, and $10 billion from securities sales, capital leases and bank borrowings. In the same period, the members of IATA, who constitute substantially all the international airlines including many of the U.S. airlines, spent and raised considerably greater amounts.

There are various estimates of the total amount which has been or must be raised during the decade of the 1980's. For the U.S. airlines, the amount falls in a range between $15 billion and $40 billion although higher estimates are not hard to find. The final figure will depend on how much *can* be raised by a group that today is causing great concern to its creditors and dismay to its shareholders. It is likely that the privately owned airlines will be able to raise all the amounts which theoretical studies of their capital needs conclude that they require. In my own view, however, the airlines will have no great difficulty in raising sufficient funds to handle traffic growth during the eighties; their real challenge will be raising the funds required to keep up with technological advances and maintain their competitive efficiency.

Finding the Lion's Share

The means by which capital needs were met include funds flowing from depreciation and profit, the sale of common and preferred stocks, publicly issued debt, private placements of debt securities with insurance companies, pension funds and the like.

As you may know, airlines have large cash flows from depreciation. But airline earnings have been both meager and highly volatile. As a result, particularly with inflation, internally generated funds have provided only 60% of the funds required by airlines for new investment. Airlines have had to turn to external sources of capital to fund the lion's share of their capital expenditures.

The private placement of debt securities with large institutional lenders has been one of the most reliable external sources of capital for airlines. During the period 1970 to 1979, the trunk and regional airlines raised nearly $1.5 billion in this market. During the last year of the decade, the funds raised reached $600 million.

But several events have combined to reduce the availability of funds from the private placement market in the last couple of years. In 1981 private loans to all of industry were substantially less than the loan levels reached in previous years. The factors accounting for this dramatic reduction in the availability of funds include the cash drain experienced by the insurance industry as a result of policy loans, a significant decline in sales of whole life policies and a reduced willingness of many institutions to make fixed rate loans because of losses sustained as a result of interest rate movements. A decrease in funds and an increase in caution particularly impacted the airline industry.

Airlines have also raised capital by selling debt securities in the public market, albeit on a much less consistent basis than in the private market. Over the period 1970 through 1979, airline financing in this market totalled not quite $1.2 billion. Financing in this market by the trunk and regional airlines reached high points of almost $250 million in 1970 and $325 million in 1977, a period of rapid growth for the airline industry In the recessionary years of 1974 and 1975, and again today, airline financing in the public market has been substantially reduced. In 1981, there was only one public offering of debt by a large airline, an issue of Eastern Airlines Equipment Trust Certificates, and by 1982, only two national airlines, Southwest and Piedmont had issued debt in this market. The average airline with poor earnings and and already high debt level finds public debt financing very expensive and often impossible to accomplish on a sufficiently large scale.

Lease financing is another traditional source of funding airline capital expenditures. In the period 1970 through 1979, the U.S. trunk airlines alone used it to finance more than $2.2 billion of aircraft acquisitions. Leasing has been stimulated in the last few years by the lack of airline earnings sufficient to enable the airlines to use many of the tax benefits flowing from capital expenditures. The loosening of the tax leasing rules also has encouraged this form of financing.

It should be noted that leasing is by no means confined to the private airlines or to the United States. National carriers have been involved in it for years with respect to both new and used aircraft. They have accessed the British and German markets as well as the U.S. market. At times, a carrier has accessed two markets, taking advantage of double tax benefits in a single transaction.



Cashing in on Stock

Another source of airline financing is the sale of common and preferred stocks. During the period 1970 through 1979, U.S. trunk and regional airline financing in the public equity market was about $1 billion. As in the case of public debt financing, this market has not always been open to airlines and, as a result, the amount of such financing done in the public markets has been done by the formerly regional, now national, airlines and by the so-called start-up airlines.

A continuing source of capital for airlines has been bank debt. Most airlines, through revolving credit arrangements or otherwise, have utilized bank debt to cover variable cash needs. At times when other financing has been relatively unavailable or very expensive, airlines have tended to rely on bank debt for more permanent capital. In times of economic difficulty, such as in 1970, 1975 and the present, bank debt has had a tendency to peak. Usually this is followed by a period of tightness in bank credit which reduces short term debt quite sharply.

We have been going through a period when negative earnings and the tightness of other capital sources has caused a significant increase in bank debt. Since the great majority of this has been on a floating rate basis, it has been quite burdensome to the carriers involved. An airline's desire to be free from the burdens of floating rates and a bank's desire to restrict exposure to the airline industry can be expected to cause sharp reduction in bank debt as rapidly as this can be accomplished.

Looking to the Eurobond Market

The U.S. airlines have not restricted their search for capital to this side of the ocean. Although, to date, only a few transactions have been consumated, U.S. airlines are increasingly exploring overseas financing. One source of capital, the Eurobond market, has been increasingly patronized by American industry generally, and to a limited degree by airlines. More of this can be expected.

Although actual transactions have been rare, airlines also have been looking to sources of Yen, Swiss Francs and other currencies. As the obtaining of capital becomes more difficult, the search for new and different sources will become more heated.

One very important source of capital is associated with the purchase of aircraft. The Export-Import bank in this country, the Export Credits and Guarantee Department in the U.K., and similar institutions in France, Germany and Brazil provide subsidized financing to help sell their national products. This below market rate financing is often decisive in the selection of aircraft and often has the effect of making aircraft cheaper to foreign than to domestic airlines. The significance of financing help is suggested by a recent charge by Fairchild that Brazil's low rate financing of the Bandeirante turboprop aircraft is economically equal to a 30 percent cut in the purchase price. At times, debt financing can be arranged through such export financing asset sources when it simply would not be available elsewhere.

So far, the discussion has dealt primarily with U.S. airlines. Would the foreign carriers, particularly those which are government owned present a different picture? In many respects, the answer is no. Foreign airlines not only avail themselves of Export-Import Bank financing in this country but utilize the purely private markets as well, both here and in Europe. Foreign carriers are also particularly prone to enter into lease financing here. On the other hand, foreign airlines rarely tap the U.S. private placement or public debt or equity markets.

But there is one important respect in which foreign airlines differ. Since most are government-owned and they have access to government funds for their capital needs, they have a very different competitive posture.

As an example, Air France and British Airways have suffered serious financial reverses in recent years. In 1980 and 1981 Pan Am suffered total operating losses of $415 million. By selling certain assets, such as its hotel chain, at a profit, Pan Am was able to show a total net profit of about $61 million, but in the process, it virtually exhausted its credit. Today, it is doubtful that it could raise a very significant amount of money. Certainly its ability to finance new aircraft is seriously constrained.

Surviving by Government Subsidy

During the same period, British Airways and Air France also suffered very large losses. But no one contemplates that either of these carriers might go out of business or be denied credit to do whatever is competitively important. A government guarantee will cure any misgivings. One can be confident that their capital needs will be met.

Due to this government backing, foreign airlines, many of which have been chronically unprofitable, are replacing the older models in their fleets with newer and more efficient aircraft and selling their old planes to U.S. carriers. This and other aspects of assistance by foreign governments to their carriers present an ominous threat to the future of U.S. airlines in international service.

There is a real danger that privately-owned carriers which lack either the credit, the earnings or the government support required to keep their fleets at a high level of competitive efficiency, will be crowded out by foreign airlines that have government support. A year or two more of the economic blood-letting that now characterizes many international markets may well cripple several U.S. carriers seriously enough to impair their competitive vigor.

Despite this threat from foreign airlines, most of our airlines will be able to obtain the capital they need for continued growth in the 1980's. How great this growth will be is highly debatable, but historically, airlines seem rarely to have lacked the capital to provide adequate capacity. Usually, as now, the problem is one of too much capacity rather than too little. The real problem will be to keep up with technology and for many, this will prove most difficult. Those who can may be expected to gain at the expense of those who cannot and in time to eliminate them from the market.

Nevertheless, the capital markets have historically demonstrated a remarkable ability to adapt to changes in the economic environment. One has only to look at the wide variety of new instruments that have been developed within the last year to tap the capital markets — including original issue discount bonds, debt equity swaps, and high premium convertible bonds — to realize the capital markets of the world continue to be resilient and responsive to deserving companies and projects.

Charles Tillinghast, Jr. *is Vice-President of Merrill-Lynch, Fenner and Smith, Inc., as well as Managing Director in the transportation department of the Capital Markets Group. During his past career, he was successively President, then Chairman of the Board of Trans World Airlines from 1961-1976. At the same time he was a member of the Executive Committee of the International Air Transporation Association from 1969-1975. Mr. Tillinghast holds a Ph.D. from Brown University and is a graduate of the Columbia University Law School.*

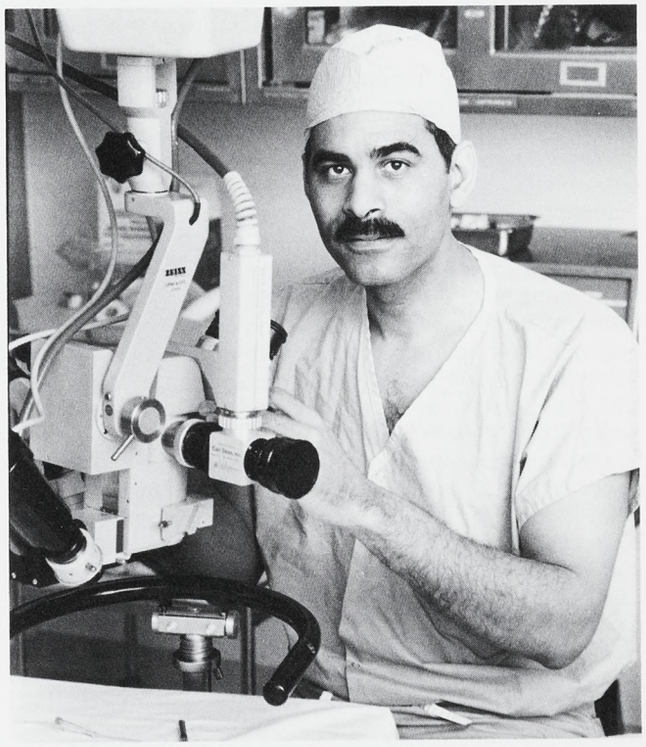
Engineer with an Eye for Medicine

He always wanted to create something with his hands. He knew he had a sharp eye, steady hand, and a mind for math. The logical career sounded like electronics engineering. "It was a good first choice," Dr. Guillory smiled, "but only the beginning." It doesn't explain how today he holds the dual appointments of Assistant Clinical Professor in Pediatrics, as well as Assistant Attending Physician in Ophthalmology at Mount Sinai Medical Center in New York.

The complex twist of careers does have its logic, but it is the personal logic that comes from Samuel A. Guillory's belief in being open to new branches of knowledge and to guidance from gifted professionals with a sense of foresight. Before graduating from Northrop University with a bachelor's degree in electronics engineering in 1967, Samuel wrote a paper about building an artificial eye which would actually be able to "see." He remembers Mr. Taraleshkov encouraging him to continue studies in bio-medical physics. The immediate result was Samuel's job with Electro-Optical Systems, a division of Xerox Corporation, working in the semiconductor physics department and doing research with infrared vidicon image tubes. Biomedical physics began to sound even more intriguing, so Samuel applied to the smaller medical schools with both M.D. and Ph.D. programs. Accepted at Mt. Sinai School of Medicine of the City University of New York, he learned to his surprise that clinical medicine was more rewarding to him. He put research goals aside for the moment and prepared for a specialization in pediatrics.

It was just by chance, during an emergency medical course taken at USC Medical Center one summer,that Samuel happened to pick up a book on ophthalmology surgery. The one-time electronics engineer had never really forgotten his interest in bio-medical electronics and was fascinated with the specialized electronic instruments used in clinical and research ophthalmology: the ocular sonograph, ultrasound diagnostics and therapeutics. Ophthalmology surgery was also the opportunity he needed to work with his hands. Just the accidental choice of books during a break outside the USC emergency room showed Samuel Guillory the crux of all his career interests: he would become an ophthalmology surgeon.

Returning to New York, he completed his internship in pediatrics while preparing for post-graduate studies in ophthalmology. In 1978, he became Chief Resident of the Department of Ophthalmology at Mt. Sinai Medical Center. In 1979, he was also appointed Clinical Fellow of Diagnostic Ultrasonography at Cornell Medical Center. The diversity of his medical, scientific, and engineering interests were beginning to converge.



Between 1973 and 1975, he received Honors in Medicine, Pediatrics, and Microbiology/Infectious Diseases from Mt. Sinai Medical Center. He also received Honors in Radiology from Montefiore Medical Center, Bronx, New York, as well as, the Bela Schnick Pediatric Prize from the Department of Pediatrics, Mt. Sinai Medical Center, New York.

A member of many medical societies, he is also a Fellow of the American Academy of Ophthalmology and a member of the New York Academy of Science. He is licensed by the State of California, Louisiana, New Jersey and New York, as well as a Diplomate of the American Board of Ophthalmology and the National Board of Medical Examiners.

Aside from his private practice, his work as professor of pediatrics and attending ophthalmologist, Dr. Samuel Guillory stil thinks about that paper he wrote as an engineering student about building the artificial eye capable of sight. Another twist to his career seems about to incorporate that first interest in bio-medical engineering. "I haven't forgotten," he said, "that I wanted to create something with these hands, and I will." It is not unreasonable to believe him. The artificial eye may be that bio-medical electronics engineering contribution he envisioned as an engineering student at Northrop University seventeen years ago.

"Speaking of the way time changes things," he smiled. "I want to organize a 20 year class reunion in 1987 for all those engineers of the Northrop University Class of '67. I think it's time to share experiences and renew friendships."

The Class of '67 may contact Dr. Samuel L. Guillory at his office address: 1141 Park Avenue, New York, New York, 10028.

A Computer Game for All Airlines

Robert Zafran



DECI: AMMTS Page 1 **STATUS:** current
AMMTS SYSTEM DEMONSTRATION
AIRLINE MAINTENANCE MANAGEMENT
TIME: 1352 **DAY:** Wednesday **DATE:** 01/25/84
CANX: Flight 731
DELAY: Flight 129 delay 20 hours:
Engine failure. Part Desc JT9D-7R4D
CREW: work slow down for A&P mechanics
WEATHER: Smog Alert Stage 2
ALERT: Flight 761 calling for
emergency landing
COMMENT: call for immediate decision
Press (ESC) Key for more information

The maintenance operations manager makes the daily decisions affecting an airline's efficiency and safety and if the decisions are too late or wrong, more than just an airline suffers the loss. The maintenance manager does not have the luxury of being able to make mistakes during the real-time operation. Mistakes in aircraft management are too costly.

Now with a new computer game, maintenance managers *do* have the opportunity to train and practice in a "safe" environment. Yook Y. Chia received her M.B.A. from the Department of Business at Northrop University and wrote her Master's thesis on a computer simulation management game to be used as an educational tool for managers in planning, coordinating, and controlling all aspects of maintenance operations. Ms. Chia's program is designed to operate on a micro computer, and to present a realistic, overall view of maintenance operations to increase a manager's awareness and sensitivity to the variety of factors involved in the decision-making process.

Ms. Chia presented her Airline Maintenance Management Training System (AMMTS) last November at the Symposium of Simulation and Modeling which was sponsored by the International Association of Science and Technology for Development, in Orlando, Florida. Ms. Chia used Trans World Airlines at Los Angeles International Airport as the system demonstration model, but she says that the program can easily be adapted to replicate the abilities and needs of any other airline, or even expanded to incorporate most types of industry.

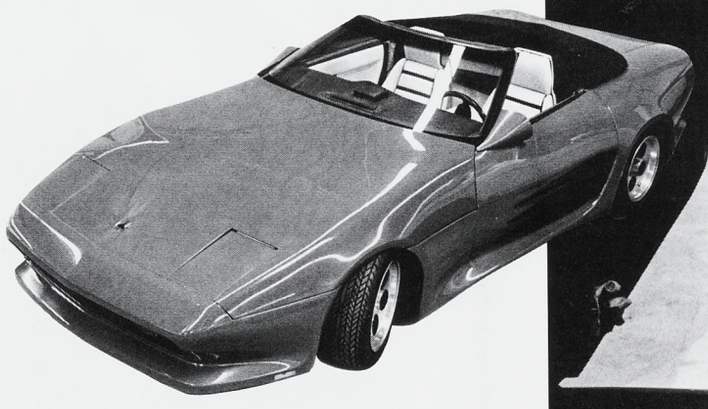
The computer simulation is inviting both to managers who would play the "game," and to their airlines. The managers have the opportunity to train and learn in a non-atomistic, non-traditional environment where their mistakes cost them points in an overall score at the end of the game, rather than costing time, money, perhaps their job, and possibly even passengers' lives. As a teaching device, the computer game is friendly and helpful to the player/manager by recognizing, encouraging, congratulating, and rewarding the player's correct choices. Airline companies find the computer simulation appealing for the obvious reason: it trains personnel while improving the airline operation system itself without occupying or risking the company's aircraft, or staff resources.

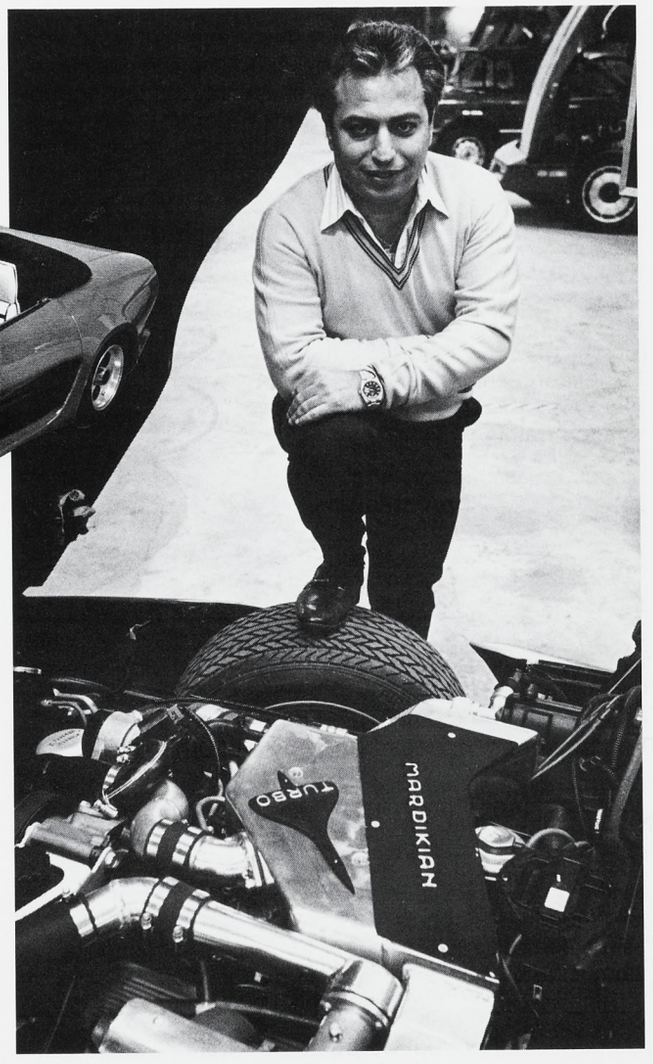
Although the AMMTS simulation is risk-free, in that it is only a game, it does recreate the sense of psychological pressure and situational crisis which the manager must face daily. In addition, there is a "hidden hand" within the simulation, which Ms. Chia has designed to introduce the unexpected into the routine of maintenance operation decisions. Those unexpected problems within the program involve work slowdowns, employees' walkouts, unavailability of replacement parts for aircraft, unexpected foul weather in unlikely locations, and other aspects of the "real" environment in which managers must work and aircraft must fly.

Yook Chia's Airline Maintenance Training Management System which simulates the management of aircraft from their landing, through maintenance and servicing, to departure, is a teaching game with, as yet, no equal in the field.

Robert Zafran, Ph.D., *Associate Professor of English and Interim Chairman of the Department of Arts and Sciences at Northrop University.*

Designing the Space-Age Exotic





Albert Mardikian is famous for putting the jet-age on the road. Mardikian Motors, with factories in California, Texas, and Germany, has modified some of the world's most exotic sports cars, making them some of the world's fastest. Their motto is: "Fast. Fantastic. Legal."

"It's all based on aircraft design and engineering," said Mardikian, a 1971 graduate of Northrop University in aircraft maintenance and design engineering. "I think like an aircraft design engineer," he said pointing to the first model of his space-age exotics, the Mardikian Concorde Turbo. "Anyone who knows about aircraft design will recognize the aerodynamic body of this car," he explained. "It was named after the Concorde because I studied that aircraft in depth before beginning the car. Air slides right off the surface of this body without any turbulence build-up," Mardikian continued. Wind tunnel testing to measure the lift and drag of the air flow over the body surface resulted in a low .27 drag coefficient. "The low spoilers stop the air from rushing under the car and lifting it off the road," he explained. "We found a one inch variation in the distance of the spoiler to the ground can make a 30 percent difference in the handling of the car."

Within the next few months the Mardikian Concorde Turbo will make its appearance in Paris, then Geneva, and perhaps even in the movies. Preliminary Mardikian testing of the new space-age exotic indicates a take-off acceleration rate of 0-60 mph in 5.5 seconds and a top cruising speed of 180 mph. The 3100 pound Concorde with its turbo-charged 350 cubic inch engine still manages a fuel efficiency rate of 16 mph in the city and 23 mph on the highway. Production of the low-riding sports car will be very limited. Only 30 cars are projected for 1984, and each will be customized to the owner's special requirements.

With an international reputation as one of the best in design modifications for high performance exotic cars, Mardikian made the prototype Corvette convertible, the prototype Honda convertible, and is now preparing to cut and remove the top of a $100,000 Ferrari to make the Ferrari convertible prototype. He has built the world's only stretched Ferrari limousine and is now equipping an armored limousine with M-1 firing systems for exhaust pipes, smoke screen generators, and jettisoned nails for the private defense of foreign state officials.

His philosophy? "Nothing is impossible."

Mardikian saw that Europe had the exotic cars and America didn't. So, he took the Ferrari and Lamborghini, and legalized them for United States driving requirements. Now he has another crazy plan. He will design and build a car with automatic fast disassembly capable of converting from road to water and finally, of course, become airborne. "I am working on the plans now," he smiled. "It will happen very quickly."

UPDATE

Hughes 500C Flies In

When Hughes Helicopters, now a subsidiary of McDonnell Douglas, donated a Hughes 500C to Northrop University, they had their Flight Test Pilot, **Brad Donovan**, fly it in. The 1972 graduate of the Airframe and Powerplant Technician program landed the 500C right at the door to the helicopter hangar which now houses a collection of 13 operational helicopters used in the inspection and maintenance training program at Northrop University.

Communication is the Goal

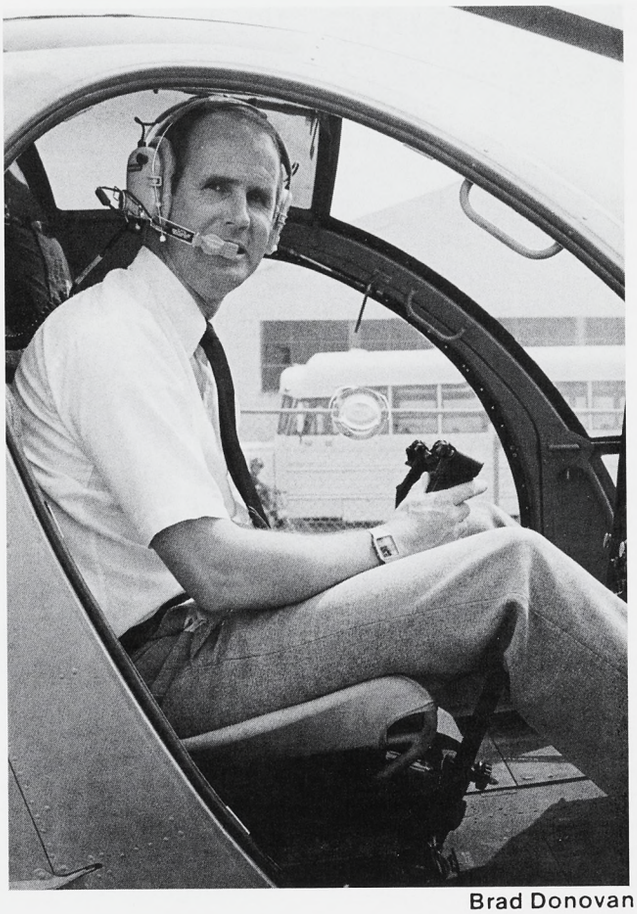
With the goal of communicating Northrop University's engineering programs nationwide, **Dr. George Shen,** Chair of the Division of Aerospace, Mechanical and Civil Engineering, announced a working strategy to increase industry contact through joint research projects, adjunct faculty from industry R&D, as well as participation in national conferences.

New Faculty from Industry: Vehicle Design and Flight Control

Dr. Leland Nicolai, recognized aircraft design educator and author of *Fundamentals of Aircraft Design,* began teaching Vehicle Design in the Division of Aerospace, Mechanical and Civil Engineering at Northrop University in 1983. Dr. Nicolai is concurrently the Manager of Aerosciences at Northrop Corporation, Aircraft Division, in Hawthorne. A retired Air Force Colonel, Dr. Nicolai is also the key lecturer of the annual Aircraft Design Short Course held in Dayton, Ohio.

Jerry Lockenour, Manager of Flight Control Technology at Northrop Aircraft, is also adjunct professor teaching the Control of Aerospace Vehicles at Northrop University. He currently works in advanced research on flight control systems, flight simulation, and is responsible for the implementation of flight control systems, both hardware and software, on board aircraft. Previously, Lockenour completed a ten-year program with NASA HiMAT investigating remotely piloted research vehicles in advanced fighter aircraft.

Dr. Robert Canady, Dean of Faculty, described the University's adjunct faculty from industry as the high ground in contemporary engineering education. "They provide the undergraduate student the advantage of a direct look into immediate industrial developments, as well as an exposure to advanced research areas for future industrial application," he added.



Brad Donovan

Industry Leaders Discuss Aircraft Design

The AIAA Los Angeles Section Invited Lecture Series held at Northrop University from February through April presents state-of-the-art surveys in aircraft design, defining accomplishments, current problems, and future directions.

The presentations by national representatives of Wright-Patterson AFB, General Dynamics, Rockwell International, Boeing Military Airplane Company, Lockheed-Georgia and others, include topics on Soviety Military Aircraft Design and Aircraft Design at the "Skunk Works".

New Course in Composite Materials

Because of its state-of-the-art nature, the new course on composite materials technology attracted not only upper division engineering students, but practicing engineers from industry. Taught by a special group from Northrop Corporation under the direction of **Dr. Mohan Ratwani,** the classes are held in the Division of Aerospace, Mechanical and Civil Engineering. Future courses in the field include: Application and Design of Composite Materials I and II.

A Message from the Chair, Department of Electronic Engineering

The Electronic Engineering Department initiated a major curriculum expansion this year with a choice of specialized courses in communication, microwaves, and digital design. Laboratory courses in the fields of electromagnetics, microwaves, and communications were also developed and offered. Much of the new electronics equipment and consequent lab courses were made possible through the active support of alumnus **Bill Moore**, (BS '71, MS '75) as District Sales Manager for Hewlett-Packard.

There are plans to introduce a program in Electrical Power which would lead to both the Bachelor and Masters of Science. Industry has shown strong support of the program in both curriculum development and equipment donations. I would like to express special appreciation to **Bob Bastone** of Sierracin/Harrison, and to the Los Angeles Department of Water and Power, as well as, the Southern California Edison Company for their assistance in the development of curriculum for the Electrical Power Program.

Another departmental objective is to offer a degree program in Metrology. The first step in this direction was a proposal to train precision measurement laboratory technicians for the local aerospace industry.

We still need many forms of active support from alumni as industry liaisons, curriculum development advisors, as well as fundraisers for equipment procurement through industry. We encourage all industries with specific academic and training needs relevant to electronic engineering to contact the Chair for information on special course development.

Masood Zaidi, Ph.D.
Chair, Electronic Engineering

44 11

Artificial Intelligence Conference '85

A combined conference and exhibition of software, hardware, and services used in the application of artificial intelligence and advanced computer technology will be held at the Long Beach Convention Center, April 30, May 1, and 2, 1985. The Artificial Intelligence and Advanced Computer Technology Conference and Exhibition (AI'85) is expected to attract industrial R&D specialists engineers, scientists, D.O.D. officials, business and engineering executives, academic researchers and members of the investment community.

The General Program Chairman of AI'85 will be **Dr. Murray Teitell**, Chairman of the Computer and Information Sciences Department, Northrop University. Those wishing to participate in the conference program may send a summary of their proposed paper to Dr. Teitell, Northrop University, Inglewood, Caifornia 90306.

Master of Science in Procurement and Acquisition Management

An innovative, professional degree program leading to the Master of Science in Procurement and Acquisition Management was developed through the Northrop University Law Center in cooperation with the National Contracts Management Association and the USAF Space Division in Los Angeles.

The program involves both the purchasing and contracts aspects of federal and commercial procurement cycle methodologies including government, state, and local municipality policies, and procedures; the retail industrial contract; program and administrative management, the marketing bid, proposal and quotation preparation, cost and pricing; finance and financing; changes, terminations and procurement; computer and software applications, and the entire spectrum of related subjects.

Patterned after the guidelines established by the Federal Acquisition Institute (Office of Management and Budget), the courses are designed to satisfy many of the requirements of the National Contracts Management Association (NCMA) for passing examinations for the Certified Professional Contracts Manager (CPM), and Certified Purchasing Manager (CPM) as offered by the National Association of Purchasing Managers (NAPM).

In Memoriam

Lunar Expert

Dr. Nalin R. Mukherjee, Dies

Dr. Nalin R. Mukherjee, Professor of Physical Sciences at Northrop University since 1977, died on January 21, 1984. He was one of the 127 international scientists chosen by Douglas Aircraft in 1967 to analyze lunar samples brought to Earth by the Apollo missions. The analyses by Dr. Mukherjee and his associates indicated that the formation of the moon resulted from a dust material ring orbiting Earth.

Dr. Mukherjee is recognized internationally for his expertise in kinetics, thermodynamics, polymer formation, and agglomeration at low and high temperatures and pressures. He was awarded a Ph.D. in Physical Chemistry from the University of London; a Doctor of Science in Physical Chemistry from the Imperial College of London. He was a candidate for the degree of Doctor of Sciences at the Faculty of Science, University of London, upon his death.

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engineering. Our adjunct faculty, employed in nearby aerospace corporations, are experts and practitioners in their field. We added curricula in Manufacturing Engineering Technology, Information Systems and a Master of Science in Computer Science. It is our long-term goal to develop a larger campus to accommodate our steady growth rate. All these plans and programs need human resources and funding. We need those 20,000 alumni in business and industry to keep our programs growing.
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A Message from the Chair, Department of Electronic Engineering

The Electronic Engineering Department initiated a major curriculum expansion this year with a choice of specialized courses in communication, microwaves, and digital design. Laboratory courses in the fields of electromagnetics, microwaves, and communications were also developed and offered. Much of the new electronics equipment and consequent lab courses were made possible through the active support of alumnus **Bill Moore**, (BS '71, MS '75) as District Sales Manager for Hewlett-Packard.

There are plans to introduce a program in Electrical Power which would lead to both the Bachelor and Masters of Science. Industry has shown strong support of the program in both curriculum development and equipment donations. I would like to express special appreciation to **Bob Bastone** of Sierracin/Harrison, and to the Los Angeles Department of Water and Power, as well as, the Southern California Edison Company for their assistance in the development of curriculum for the Electrical Power Program.

Another departmental objective is to offer a degree program in Metrology. The first step in this direction was a proposal to train precision measurement laboratory technicians for the local aerospace industry.

We still need many forms of active support from alumni as industry liaisons, curriculum development advisors, as well as fundraisers for equipment procurement through industry. We encourage all industries with specific academic and training needs relevant to electronic engineering to contact the Chair for information on special course development.

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Masood Zaidi, Ph.D.
Chair, Electronic Engineering

Artificial Intelligence Conference '85

A combined conference and exhibition of software, hardware, and services used in the application of artificial intelligence and advanced computer technology will be held at the Long Beach Convention Center, April 30, May 1, and 2, 1985. The Artificial Intelligence and Advanced Computer Technology Conference and Exhibition (AI'85) is expected to attract industrial R&D specialists engineers, scientists, D.O.D. officials, business and engineering executives, academic researchers and members of the investment community.

The General Program Chairman of AI'85 will be **Dr. Murray Teitell**, Chairman of the Computer and Information Sciences Department, Northrop University. Those wishing to participate in the conference program may send a summary of their proposed paper to Dr. Teitell, Northrop University, Inglewood, California 90306.

Master of Science in Procurement and Acquisition Management

An innovative, professional degree program leading to the Master of Science in Procurement and Acquisition Management was developed through the Northrop University Law Center in cooperation with the National Contracts Management Association and the USAF Space Division in Los Angeles.

The program involves both the purchasing and contracts aspects of federal and commercial procurement cycle methodologies including government, state, and local municipality policies, and procedures; the retail industrial contract; program and administrative management, the marketing bid, proposal and quotation preparation, cost and pricing; finance and financing; changes, terminations and procurement; computer and software applications, and the entire spectrum of related subjects.

Patterned after the guidelines established by the Federal Acquisition Institute (Office of Management and Budget), the courses are designed to satisfy many of the requirements of the National Contracts Management Association (NCMA) for passing examinations for the Certified Professional Contracts Manager (CPM), and Certified Purchasing Manager (CPM) as offered by the National Association of Purchasing Managers (NAPM).

In Memoriam

Lunar Expert

Dr. Nalin R. Mukherjee, Dies

Dr. Nalin R. Mukherjee, Professor of Physical Sciences at Northrop University since 1977, died on January 21, 1984. He was one of the 127 international scientists chosen by Douglas Aircraft in 1967 to analyze lunar samples brought to Earth by the Apollo missions. The analyses by Dr. Mukherjee and his associates indicated that the formation of the moon resulted from a dust material ring orbiting Earth.

Dr. Mukherjee is recognized internationally for his expertise in kinetics, thermodynamics, polymer formation, and agglomeration at low and high temperatures and pressures. He was awarded a Ph.D. in Physical Chemistry from the University of London; a Doctor of Science in Physical Chemistry from the Imperial College of London. He was a candidate for the degree of Doctor of Sciences at the Faculty of Science, University of London, upon his death.

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5. ☐ I pledge my support to the new programs at Northrop University with my tax deductable contribution of $_____
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Northrop University:
Ingenuity and Innovation in Education



A special 20,000 people in the world have something in common. They are Northrop University Alumni. Our graduates in engineering, engineering technology, business and management, law, aircraft and helicopter maintenance, all share the spirit of Ingenuity and Innovation in Education:
John K. Northrop's and James L. McKinley's vision to transform a small aviation mechanics training school into a great university. Northrop University is now at the forefront of technology education. This academic year, a Computer Graphics Research Laboratory and an avionics program were established. A factory of the future for studies in Robotics is now in progress with help from McDonnell Douglas and Cybotech. Plans for a Composite Materials Research Laboratory are underway with the help of local aerospace companies. We increased the expertise of our faculty with industry research engineers in aerospace, computer science, and electronic engineering. Our adjunct faculty, employed in nearby aerospace corporations, are experts and practitioners in their field. We added curricula in Manufacturing Engineering Technology, Information Systems and a Master of Science in Computer Science. It is our long-term goal to develop a larger campus to accommodate our steady growth rate. All these plans and programs need human resources and funding. We need those 20,000 alumni in business and industry to keep our programs growing.
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